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THE PALACE OF WAR AND OF THE NAVY AT THE EXPOSITION OF 1900.

THE competition opened to all the architects of France for the construction of the palace of the ministers of war and the navy at the Exposition of 1900 has just been judged by a commission of generals and architects.

The first prize was awarded to Messrs. Umbdenstock and Auburtin, who presented a project that was exceedingly remarkable from an æsthetic point of view, and possessed the stamp of an originality that does the greatest honor to the young artists.

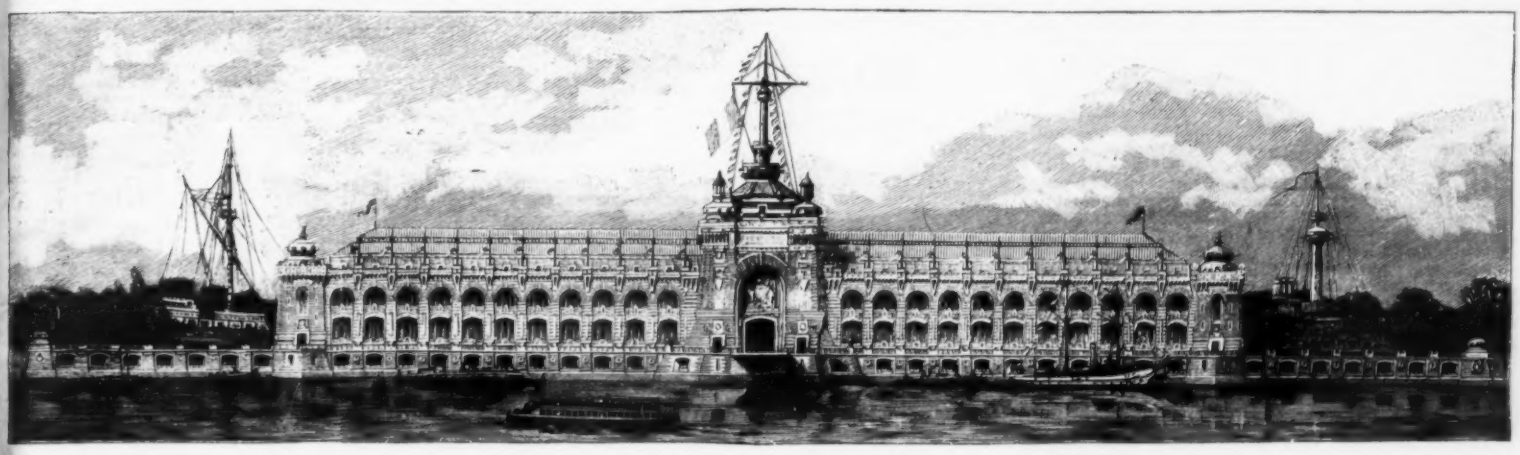
These gentlemen conceived the ingenious idea of showing the public the great transformation that has taken place in our navy during the last two centuries. At the left extremity of their design they have placed the poop of one of those immense galleys that formed the navy of Louis XIV, with its antique guns, its wonderful blue and gold decorations, its royal flag and the rigging of sail navigation that characterized the ancient navy.

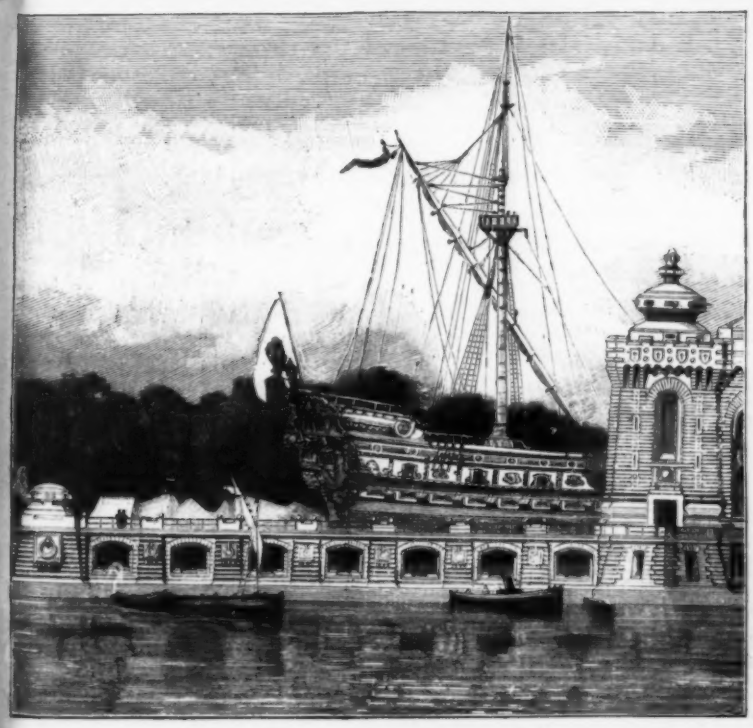
This ship enters the palace, and, after undergoing all the transformations of progress, makes its exit in the form of a modern armorclad, provided with steel turrets, huge smoke stacks, a fighting mast armed with revolving guns, and, in a word, equipped with everything that goes to make up the modern naval vessel.

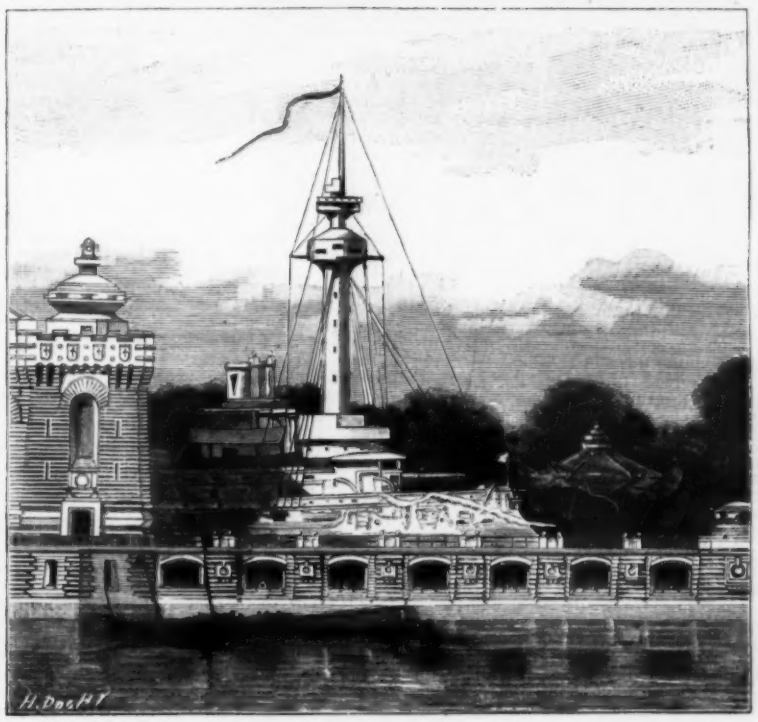
In the interior of the palace, a large hall is reserved for the military balloon of the Meudon aerostatic park. This new edifice will be built upon the bank of the Seine along Quai d'Orsay, between Rapp and Bosquet Avenues. At the foot of the structure a small port will permit the minister of the navy to exhibit the light vessels of our fleet.

A foot bridge established opposite the main entrance will connect the two banks of the Seine.

This palace will certainly be one of the great attractions of the Exposition of 1900.—Le Monde Illustré.







THE PALACE OF THE MINISTERS OF WAR AND OF THE NAVY AT THE EXPOSITION OF 1900.

THE AMERICAN BICYCLE—ITS THEORY AND PRACTICE OF CONSTRUCTION.*

By LEONARD WALDO, D.Sc. (Harv.)

OVER the portals of a great nation are written in armaments of steel the words "Dieu et mon droit." Enshrined in the hearts of another great nation and crystallized from the furnace of war are those other words "E pluribus unum." The one sentiment has built an industrial condition founded on the growth of the individual mechanic, whose personal handiwork should remain a large part of the value to be sold in England's products to the rest of the world, while the second sentiment has led where possible to the abdication of the direct result of hand labor, and has sought for the magnification of such labor by the substitution of the automatic machine, whose intelligence is that of the single man, but whose output is that of a hundred men working with untired muscle and ever fresh brains. Eleven years ago, and before an equally distinguished audience in this hall, we considered the application of machinery to the piece making of watches according to what was then known as the American plan; tonight we shall consider an application of the same system, but in a larger field of engineering.

We are apt to mistake the true relation of the bicycle to the human economy. There are two broad channels through which human efficiency becomes available: one by utilizing energy exterior to ourselves, as in the driven horse or the water power at Niagara; and the other where the entire energy is derived from the human frame, and is made skillful and useful without magnification, but with an economy for the direct object in view which is proportioned to the energy which can be saved from apparently necessarily connected and attendant operations. If a man can move without the loss of energy of lifting and stopping his feet at each step, he has gained an important economy of energy.

Now man is profoundly interested in anything which is strongly individual, and which is a virtual extension of his own powers. The Tourte bow is none too good for the violinist. The utmost care is given to the shape of the sculler's oar. A half ounce addition is destructive to an individual tennis racquet.

It is this principle of individuality which separates the skate and the bicycle from all other means of transportation. No energy is added, none can be added. The chemical energy of digesting and, therefore, combusting food is absolutely all there is, and yet the man moves with the speed of the railway express. Is it a wonder that with the rapid passing of the contrivance and toy to the splendid machine of 1898, in which is incarnate the highest state of the art in every single mechanical procedure involved in its production, there should be a history of mechanics for the period concerned.

See the first safety—whether tinkered by the Scotch cooper, Gavin Dalzell, of Lesmahagow, in 1846, or made earlier by McMillan, of Courthill and Dumfries, I know not; certain it is that the low wheels, the front steer-

* Paper read before the British Society of Arts, December 1, 1897, and published in the Journal of the Society.

ing, the back driving, the mud guard are all in it—everything but that other name for a portable good road, the pneumatic tire.

What fun old Dalzell had with his machine! The royal mail coach was pledged to its ten miles an hour, and, when it lumbered into sight, out Dalzell would get with his machine, and before, behind, would go cavorting, rousing the horses to trembling fear and the passengers to excited bets as to which could win, then disappearing in the roadway ahead to the consternation and disgust of every one but Dalzell. Good oak, good sense, what we should now call weak iron and honest work, went into this first safety; but after it came an evolution of bicycle distortion compared to which the evolution which led to the megatherium was a continued line of grace and beauty. I cannot go into this in an evening's paper, for it is the present we have much with us in the bicycle, and the history is in the books; especially in that most excellent of all books by Mr. Archibald Sharp, against which an American might file the complaint of scant attention to the American wheel.

Let us now enter upon the more technical ground of considering along what lines the manufacture of the bicycle must lie, and first how are scientific measures to be made which shall allow the constructor to express in exact numbers the progress he is able to make toward all the perfection which the state of the art allows in the individual parts. We are accustomed to think of the locomotive as a high expression of mechanical art; there is not a single part of the locomotive which has anything like the care in the selection of materials and the crucial testing which is given to the bicycle. The locomotive may be honeycombed with castings about its various parts. It is the fundamental axiom of the best American bicycle construction that every single piece is forged hot or drawn cold. The carbon and phosphorus of the steel in locomotives may vary within wide limits; in the bicycle the variation is small, and the steel is transformed into another and much stronger steel by the addition of 5 per cent. of nickel. In the locomotive the tubular construction may be irregular as to size, and drawn by regular draw bench methods. In the bicycle nickel steel tubing must be cupped up from the disk and drawn by special hydraulic presses of enormous strength and exquisite precision.

It is not as an assemblage of parts that we must finally regard the bicycle. Like the violin it is as an organic whole, under live tension, ready to answer the slightest muscular call, that it must be considered. The testing department, therefore, first regards the materials of construction, and then the machine as a whole. In our illustrations we shall see the successive stages of the preparation of nickel steel tubes. We have in such tubes the maxima of resistance to bending and breaking and crystallization under continued jar, with the minima of weight; but to reach this conclusion many thousands of tests of materials of all kinds had to be made.

Begin with the very tempting metal, aluminum. Pure, in drawn tubes, it has the specific gravity of 2·7, while steel has 7·9, so that an aluminum tube weighs but one-third of the same sized steel tube. Its strength, soft drawn, does not much exceed 20,000 pounds per square inch under most favorable circumstances, and this might be improved by the addition of something less than 5 per cent. of nickel or copper. Unfortunately, however, the metals of the aluminum class have no well defined elastic limit. When a strain which may not be one-quarter of the ultimate breaking strain is applied, the metal begins to stretch, and does not wholly recover when the strain is removed. Now let us approximate, for the purpose of comparison, by assuming that an aluminum nickel alloy tube can be made which in its soft and annealed state will stand 10,000 pounds per square inch without stretch or set, it would have three times the bulk and clumsiness of the nickel steel tube, and not one-half, probably not one-quarter, the resistance to deformation or set under strain, even if it were the same weight as steel. If the use of aluminum is advocated to lighten the frame, and sizes approaching those of steel tubes are used, then the comparison is still more unfavorable, so that the aluminum nickel taken may have only one-sixth or even one-tenth of the resistance of the nickel steel. One point must constantly be borne in mind in thinking of the material to be used in bicycle frames. It must all be reduced to the soft or annealed state. The frames have to be assembled and brazed at their joints. If the tubes are hard, the heat of brazing anneals them at such joints, and the frame is unequally strong throughout. If the attempt is made to assemble the frame by screw joints, without heat, then it is only a question of time for the racking of the frame in one to start the threaded joints and render the whole frame less taut. Thus nickel steel tubing is drawn in the tube department of the Pope works at Hartford which sometimes reaches the enormously high tensile strength of 350,000 pounds per square inch in its hard state, and to a certainty of gage not exceeding a variation of 5 per cent. from the gage thickness. With such a strength the present ordinary steel frame could be one-sixth its present weight, but it would not be good practice to so make it. The tube is immediately brought to a condition known among metal workers as that of "dead soft," i. e., as free from any temper as possible, and so that no further change can take place when the tubes are heated in brazing.

There is another reason for this, and one which reaches into the molecular physics of steel. One of the usual tests for steel tubes at the works mentioned is to clamp one end of a tube, which may be two or three feet long, in a rapidly driven lathe chuck, and leave the other end free to turn on a fixed dead center. A strong pressure by a rolling wheel is brought against one side of the tube at its middle and securely clamped, so that at every revolution of the tube it must bend at its middle point. Steam power is then applied, and the number of hundred thousand turns, and consequent bends, which the tube will stand before breaking is noted by automatic counters. This number is an indication of the fatigue, the jars, and checks the metal will undergo without taking a set or breaking. A somewhat similar method of torture is applied to the whole frame of the bicycle after the parts have been brazed together. In this latter case the base of the frame is securely clamped, as we shall see in our illustrations later in the evening, and a twisting around a circle motion given to the free top of the frame by steam power, so that it is racked in every direction. Here too the number of twists the whole frame stands is automatically recorded.

If the large class of bicycle riders who firmly believe that a bicycle is a thing animate, possessing a disposition and an obstinacy peculiarly its own, should form a society for the prevention of cruelty to bicycles, there is no such field in existence as the testing department of the bicycle company named under its chief inquisitor, the engineer of tests, Mr. Henry Souther. Not a bicycle which enters that domain lives to tell the tale. Not only are the individual parts racked and pulled with a knowledge of metallurgical anatomy, but the completed machine is clamped against a spring to a rigid frame, and then two rotating wheels with projecting blocks in their circumferences are brought directly under and against the wheels of the bicycle to be tested. Steam power, again applied, gives the bicycle wheels the continuously repeated hammering of the rapidly turning lower wheels with the projecting blocks. The roughest cobblestone pavement under the speeding machine of the scorcher is very mild treatment in comparison with this roughest of roads fast driven under the spring-loaded bicycle. Here, too, the hundreds of miles and corresponding revolutions are automatically registered to the destructive point of the weakest part of the wheel.

Once, in going through the splendid testing laboratory of McGill University in Montreal, I heard the late Eckley B. Coxe, one of the most lovable and brightest of our American engineers, say: "Why do we always test small parts of bridges and machines? Why don't we build an entire bridge truss, and then break it down—or test the shaft of a steamship at full size?" He had in mind that no metal construction can grow from the small to the large state with all of its section strengths unchanged.

The test bar, half an inch in diameter, gives a far more favorable indication of strength than a bar cut from the solid part of a full sized casting weighing tons of the same material. It is important that the strength of the whole be known and determined, and it is only possible to do this by regarding the bicycle as a unit and testing the assembled machine to destruction. This is the theory and also the practice of our greatest company, not only with reference to their own construction, but, for comparative knowledge, with reference to such forms as may be prepared by others.

Besides a system of tests which shall indicate necessities of the strengthening of parts so that the factor of safety may be the same throughout the bicycle, there is another system of tests having in view a totally different purpose, namely, the loss of work and energy which occurs in the bicycle under its normal load, and meeting a varying resistance at varying speeds. We shall see later upon the screen photographs of the beautifully accurate Webb floating dynamometers, built for the department of trade of the Pope Manufacturing Company, by which Prof. Denton, of the Stevens Institute of Technology, has made the first valuable contribution to our knowledge of the actual efficiency of types of bicycles.* There appeared at the last (Hartford) meeting of the American Society of

* The Iron Age, No. 7, October 21, 1897.

TABLE I.—COPY OF TEST SHEET No. 35.

Driving Float.

Description of Wheel, Test No. 1.	Time in seconds per 100 revolutions.	Revolutions of cranks per minute. N.	Reading of counter-poise c.m. s.	Foot-pounds delivered to crank. $2\pi S$	Average foot-lbs.
1	2	3	4	5	6
1. Model 50, Pope chainless, tire A	36·2	165·8	18	5,900	6,146
2. Gear $71\frac{3}{4} = G$	37	162·2	30 8	9,092	9,807
3. Weight on saddle = 183 pounds = L	37·8	158·7	48·8	15,489	15,300
4. Diameter of tire, 60 pounds air pressure, before loading = 27·65 = D^0	38·8	154·6	65	20,098	20,046
5.	40·4	148·5	82·5	24,502	24,484
6. Diameter of tire, 60 pounds air pressure, after loading = 27·35 = D	39·4	152·3	82·4	25,009	—
7.	38	157·9	64·5	20,369	—
8.	37·4	160·4	48·5	15,559	—
9. Rolling radius of tire = $\left[\frac{D_2}{2}(D_0 - D_1)\right]$	37·2	161·8	30·0	9,105	—
10. Circumference of track wheel = 63 inches	36·2	165·8	18 3	6,068·	—
11. Ratio of revolutions of track wheel to revolutions of crank if there was no tire slip = C	35·8	167·6	19·1	6,402	—
12.	37	162·2	30·5	9,894	—
13.	37·8	158·7	48	15,235	—
14.	39	153·9	65·1	20,038	—
15.	40·6	147·7	82	24,223	—
16.	41·2	145 6	82 8	24,110	—
17.	40	150	65·6	19,678	—
18.	38·6	155·4	48	14,017	—

Driven Float.

Description of Wheel, Test No. 1.	Revolutions of brake wheel per minute. n.	Reading of counter-poise c.m. s.	Grade in per cent. equivalent to values of s for 175 lb. rider.	Foot-pounds utilized. By brake. $2\pi s$.	Foot-pounds utilized. Average.	Foot-pounds utilized. By track wheel.	Foot-pounds utilized. Total Col. 11 + Col. 12.
10	7	8	9	10	11	12	13
1. Model 50, Pope chainless, tire A	555	1·5	0·33	1,665	1,707	915·1	2,622·1
2. Gear $71\frac{3}{4} = G$	544	5	1·11	5,440	5,412	889·8	6,301·8
3. Weight on saddle = 183 pounds = L	530	10	2·06	10,600	10,571	869·2	11,440·2
4. Diameter of tire, 60 pounds air pressure, before loading = 27·65 = D^0	519	15	3·02	15,570	15,437	846	16,281
5.	496·5	20	3·97	19,860	19,585	805·2	20,390·2
6. Diameter of tire, 60 pounds air pressure, after loading = 27·35 = D	502	20	...	20,080	—	—	—
7.	521	15	...	15,570	—	—	—
8.	533	10	...	10,660	—	—	—
9. Rolling radius of tire = $\left[\frac{D_2}{2}(D_0 - D_1)\right]$	537	5	...	5,370	—	—	—
10. Circumference of track wheel = 63 inches	555	1·6	...	1,776	—	—	—
11. Ratio of revolutions of track wheel to revolutions of crank if there was no tire slip = C	559·5	1·5	...	1,678·5	—	—	—
12.	542·5	5	...	5,425	—	—	—
13.	530	10	...	10,600	—	—	—
14.	518	15	...	15,540	—	—	—
15.	490	20	...	19,600	—	—	—
16.	470	20	...	18,800	—	—	—
17.	500	15	...	15,000	—	—	—
18.	521·3	10	...	10,426	—	—	—

Average = 521·54 = 31·234 miles per hour.

Slip Data and Efficiency.

Description of Wheel, Test No. 1.	Slip data. $C = \frac{2\pi}{63 \times 28} G\left[\frac{D_2}{2} - (D_0 - D_1)\right]$ $\frac{N}{n}$	Slip data. Per cent. of slip. $\frac{C}{100} - \frac{\frac{N}{n}}{C}$	Efficiency. With Slip. $\frac{\text{Col. 13}}{\text{Col. 6}} 100$	Efficiency. For zero slip. $\text{Col. 16} \frac{100}{100 - \text{Col. 15}}$
1b	14	15	16	17
1. Model 50, Pope chainless, tire A	3·348	3·88	42·66	44·43
2. Gear $71\frac{3}{4} = G$	3 354	3·70	63 67	66 40
3. Weight on saddle = 183 pounds = L	3·349	4·11	74·77	77·97
4. Diameter of tire, 60 pounds air pressure, before loading = 27 65 = D^0	3·357	3·62	81·22	84·72
5.	3·344	3·99	83·29	83 00
6. Diameter of tire, 60 pounds air pressure, after loading = 27·35 = D	3·297	5·34	—	—
7.	3·320	5 25	—	—
8.	3·323	4·59	—	—
9. Rolling radius of tire = $\left[\frac{D_2}{2}(D_0 - D_1)\right]$	3·319	4·71	—	—
10. Circumference of track wheel = 63 inches	3·317	3·90	—	—
11. Ratio of revolutions of track wheel to revolutions of crank if there was no tire slip = C	3·338	4·26	—	—
12.	3·345	3·96	—	—
13.	3·340	4·11	—	—
14.	3·366	3·36	—	—
15.	3·318	4·74	—	—
16.	3·228	7·32	—	—
17.	3·333	4·31	—	—
18.	3·353	3·68	—	—

TABLE II.—COPY OF TEST SHEET No. 39.

Driving Float.

Description of Wheel. Test No. 1.	Time in seconds per 100 revolutions.	Revolutions of cranks per minute. n.	Reading of counter-poise c.m. S.	Foot-pounds delivered to crank. $2\pi S$.	Average foot-lbs.
1	2	3	4	5	6
1. Model 50, Pope chainless, tire A	40·6	73·9	15·1	2,232	2,177
2. Gear $71\frac{4}{9} = G$	41	73·2	28	4,009	4,082
3. Weight on saddle = 183 pounds = L	41·4	72·5	63·2	9,164	9,207
4. Diameter of tire, 60 pounds air pressure, before loading = $27·70 = D_0$	43·2	69·4	131·8	18,294	18,391
5.	44·8	67	183·4	24,573	24,945
6. Diameter of tire, 60 pounds air pressure, after loading = $27·38 = D$	44·6	67·3	186·5	25,108	—
7.	44·4	67·6	186·1	25,159	—
8.	43·2	69·4	133·2	18,488	—
9. Rolling radius of tire = $\left[\frac{D_2}{2}(D_0 - D_1)\right]$	41·4	72·5	63·8	9,230	—
10. Circumference of track wheel = 63 inches	40·6	73·9	27·5	4,064	—
11. Ratio of revolutions of track wheel to revolutions of crank if there was no tire slip = C	41	73·2	14·5	2,123	—

Driven Float.

Description of Wheel. Test No. 1.	Revolutions of brake wheel per min. N.	Reading of counter-poise c.m. s.	Grade in per cent. equivalnt. to values of s for 175 lb. rider.	Foot-pounds utilized. By brake $2\pi N s$	Average.	By track wheel	Total Col. 11 + Col. 12
10	7	8	9	10	11	12	13
1. Model 50, Pope chainless, tire A	247	1·1	0·33	543	521	407·8	928·8
2. Gear $71\frac{4}{9} = G$	244	5	1·11	2,440	2,455	403·7	2,858 7
3. Weight on saddle = 183 pounds = L	239	15	3·02	7,170	7,185	393·8	7,578 8
4. Diameter of tire, 60 pounds air pressure, before loading = $27·70 = D_0$	233	35	6·68	16,310	16,240	381·5	16,621·5
5.	222·7	50	9·70	22,270	22,273	366·2	22,639·2
6. Diameter of tire, 60 pounds air pressure, after loading = $27·38 = D$	221·5	50	—	22,150	—	—	—
7.	224	50	—	22,400	—	—	—
8.	231	35	—	16,170	—	—	—
9. Rolling radius of tire = $\left[\frac{D_2}{2}(D_0 - D_1)\right]$	240	15	—	77,200	—	—	—
10. Circumference of track wheel = 63 inches	247	5	—	2,470	—	—	—
11. Ratio of revolutions of track wheel to revolutions of crank if there was no tire slip = C	249	1	—	498	—	—	—

Av. = 236·20 = 14·091 miles per hr.

Slip Data and Efficiency.

Description of Wheel. Test No. 1.	Slip data. $C = \frac{2\pi}{63 \times 25} G\left[\frac{D_2}{2} - (D_0 - D_1)\right]$ Per cent. of slip. $\frac{N}{n}$	$100\frac{C\frac{N}{n}}{C}$	Efficiency. With slip. Col. 13 / Col. 6 ×100	For zero slip. Col. 16 × 100/(100 − Col. 15)
18	13	15	16	17
1. Model 50, Pope chainless, tire A	3·342	3·07	42 66	43·62
2. Gear $71\frac{4}{9} = G$	3 333	3·31	70 03	72·35
3. Weight on saddle = 183 pounds = L	3·297	4 38	82·32	85·93
4. Diameter of tire, 60 pounds air pressure, before loading = $27·70 = D_0$	3 357	2 61	90 38	93·23
5.	3 424	3 60	90 76	94·63
6. Diameter of tire, 60 pounds air pressure, after loading = $27·38 = D$	3·291	4·55	—	—
7.	3 314	3 80	—	—
8.	3·328	3·48	—	—
9. Rolling radius of tire = $\left[\frac{D_2}{2}(D_0 - D_1)\right]$	3·310	4 00	—	—
10. Circumference of track wheel = 63 inches	3·342	3·07	—	—
11. Ratio of revolutions of track wheel to revolutions of crank if there was no tire slip = C	3·402	1·33	—	—

Mechanical Engineers papers on and a discussion of the efficiency of bicycles, and these papers, together with Prof. Denton's, must be taken as the beginning of our technical special investigations into the energy economies of the bicycle. Prof. Denton's curves showing for varying foot pounds of energy delivered to the bicycle crank, and for varying foot pounds of resisting energy put on the brake, and which represents the resistance to be overcome by the rider under varying conditions, are in these diagrams correlated to the curve of efficiency, which shows the per cent. of the total energy exerted by the rider which is utilized in moving the bicycle forward. So much interest has been roused by the final success in building automatic gear-cutting machinery, so that the direct-geared bicycle is now permanently in the certainties of American manufacture, that I quote you the results of Prof. Denton's investigations, referring you to the published paper for its details. He says:

"The results of the investigation show that both the Columbia chainless wheel and the Columbia chain wheel wastes in its propelling mechanism from about 15 per cent. at high speed (30 miles per hour) and on low grades to 7 per cent. at moderate speed (13 miles per hour), and on heavy grades of the power applied at the cranks by a rider weighing about 180 pounds, provided the chain of the chain wheel is cleaned and well lubricated.

"Any difference of efficiency of the two styles of propelling mechanism with a clean, lubricated chain is equaled by the difference liable to exist in the power absorbed by two tires of the same grade, which is about 1 per cent. of the average power expended by a rider.

"It is probable that the efficiency shown by the chainless wheels in the tests will be maintained for long periods of road use without any cleaning or lubrication of the mechanism, but the efficiency of the chain wheels, after a short road use, may be considerably less than that shown by the tests by the soiling of the chain.

"The tests of other makes of chainless wheels show that differences in the power wasted by different constructions of tire and by lack of proper stiffness of frame, combined with an arrangement of the gears whose efficiency is affected by the distortion of the frame by crank thrust, may make the waste of power reach 50 per cent. of the energy applied to some chainless wheels at high speeds on low grades."

I have gone thus at some length into the forms of testing in the typical and greatest of our American works, because if a knowledge of facts is the foundation of science, it is especially the foundation of bicycle structure; and the art is too new to have a literature or established traditions.

The next thing after the laboratory determinations have furnished the data for construction is the field trial. This is done with the most careful system. Paid riders, with marked routes and blank reports to be filled out in minute detail, are dispatched in all kinds of weather and over all kinds of roads. On the screen we shall see later two such riders who have just come in, one on a chainless wheel, and the other with a chain wheel, both over the same rainy, muddy, sandy in parts, and hilly route. From these reports, which are indorsed by inspectors in distant towns, the opinion is formed as to the wisdom of constructions planned or new things to be attempted. Single wheels embodying some special idea are thus ridden as much as 15,000 miles under different riders, with an accurate register of every mishap.

One other point ought to be mentioned in this connection, something which for a better name may be called the democratic council.

At least once in every day, and sometimes many times in a day, the ubiquitous inventor appears. It may be the man who is prepared to prove that he takes out four times the energy he puts in, by his particular contrivance, or it may be a thing of merit. Whatever it is, if it is endorsed on a preliminary examination, it is fully discussed in a public meeting of riders, salesmen and general officers, under all the forms of parliamentary rules. It has always been the policy of this particular company to avoid the making of what are known as bicycle accessories, with the exception of a hand kit of small tools, which we shall show later on the screen.

So much for the determination of the facts, and the democracy of the advice. It is not strange that the manufacture should have assumed large proportions; this particular company has as high as 3,800 names on its pay rolls at times, its buildings are spread over 19 acres of the city of Hartford, and its investment is estimated at £1,000,000. The output per day reaches 600 finished bicycles in the busy season, and preparations are making to extend this output with the advent by most of the principal makers of the chainless wheel.

All of the essentially American characteristics of such highly organized machine working companies are carefully carried out. Plenty of clear daylight in every department; lunch rooms, where at cost price soups and the essentials of a hot meal are furnished by the company's cooks; rooms with comfortable fittings of tables and chairs, with good literature or games for the leisure hours; long, separate water tanks for easy washing, and separate lockers for those who wish to keep clothes or property under private lock and key; strikes unthought of; the clear sunlight through long hours; every man at his machine or his dozen machines—his only thought and pride that it be of the best of its kind! O sons of England, that you could only see in your striking work meetings that your work interests and your capital interests are the same! Not always will there be a high protective tariff in the United States for the benefit of European industries in the markets of the world. When that day comes, and scales of value are the same in the civilized world, you will miss the help of the multiplying machinery which you now refuse.

The company's works are complete within themselves. The making of rubber tires, described in Engineering by its correspondent, Major Wiley, is carried on for its own benefit and that of most of the other American companies. Steel tubing, formerly brought from England, is now made in their own tube works to limits of precision in drawing as follows:

Tubes 1 inch diameter and over must not exceed the gage thickness by more than 0·003 inch, nor be less than their gage thickness by 0·001 inch. Tubes less than 1 inch diameter must not exceed their gage thickness by more than 0·002 inch, nor be less than the gage thickness by more than 0·001 inch. In tubes of No. 21 B. W. G. (0·032 inch) and thicker, the gage extreme variation of thickness does not exceed 0·003 inch, and it does not exceed 0·002 inch for tubes less than 0·032 inch thick.

It may interest those present concerned in tube drawing that these figures are enforced. I cannot, in the limits of this paper, follow the consecutive operations of making the bicycle. You will see on the screen photographic sections of the bicycle in various stages, and I think they will reveal the answer to most of the questions which suggest themselves to your minds. The essential thing to be remembered is that the frame is considered the unit for work. Nothing is done in the way of fitting or centering any of the parts until the completed frame with its reinforced joints, with all the brazing, heating or other distorting influences, is complete. The entire frame is then securely held in gaged clamp vises and the boring and centering done by tools also rigidly set to gage.

The interchangeability of parts under this system is the same as in that other product of American machinery—the American watch. Another point is the nature of the hardening of the spherical bearings on

TABLE III.—EFFICIENCY AT EQUAL FOOT-POUNDS DELIVERED TO CRANK AS TAKEN FROM CURVES.

		Number of Sheets.	Date of Test.	Gear.	Weight in Saddle, in lbs.	Average miles per hour.	Foot-pounds delivered to Crank as taken from Efficiency Curves on Plates. 25,000	23,000	20,000	17,000	12,000	10,000	8,000
	1	2	3	4	5	6	7	8	9	10	11	12	13
Columbia chain	1 Wheel 1.—No. 80 1⅛ in. Hartford Tire A	29	Aug. 26	71⅛	123	13·25	...	93 75	93·50	92 75	90 75	89·62	88·50
	2 Wheel 1.—No. 80 1⅛ in. Hartford Tire A	30	Aug. 26	71⅛	183	13·10	...	93·00	92·90	92 50	90·00	88 25	85·50
	3 Wheel 1.—No. 80 1⅛ in. Hartford Tire B	38	Aug. 28	71⅛	(Saddle 63) (Pedal 120)	12·93	...	94·00	93·10	92·25	89·00	86·80	83·80
	4 Wheel 1.—No. 80 1⅛ in. Hartford Tire B	37	Aug. 28	71⅛	183	12 56	...	...	94·30	93·50	91·20	89·75	87·61
Columbia chainless	5 Wheel 2.—No. 80 1⅛ in. Hartford Tire A	33	Aug. 27	71⅛	123	12·93	...	93·00	92·75	92·25	90·75	89·75	88·50
	6 Wheel 2.—No. 80 1⅛ in. Hartfore Tire A	34	Aug. 27	71⅛	183	12·98	...	92·75	92·50	91·65	89·50	87·75	85·00
	7 Wheel 2.—No. 80 1⅛ in. Hartford Tire A	30	Aug. 28	71⅛	183	14·01	94·75	94·50	93·75	92·65	89·25	87·10	84 00
	8 Wheel 2.—No. 80 1⅛ in. Hartford Tire B	31	Aug. 26	71⅛	123	12·94	...	94·00	93·75	93·40	91·50	90·25	87·50
	9 Wheel 2.—No. 80 1⅛ in. Hartford Tire B	32	Aug. 26	71⅛	123	13·12	...	93·75	93 50	93 25	91 50	90·25	88·50
	10 Wheel 2.—No. 80 1⅛ in. Hartford Tire A	40	Aug. 28	71⅛	(Saddle 63) (Pedal 120)	13·80	...	94·25	93·75	93·00	90·40	88·50	85·75
Other makers	11 Wheel 3.—1⅛ in. Tire 3	37½	Aug. 30	74·75	183	13·86	90·75	90·50	90·10	89·40	86 85	85·10	82·60
Old chains	12 Wheel 4.—No. 80 1⅛ in. Tire C	43	Aug. 31	63·8	183	11·53	...	...	89·50	88·25	84·00	81·25	77·00
Foreign "	13 Wheel 5.—1⅛ in. Tire 5	42	Aug. 31	63·7	18,	11·93	...	...	90 00	89·00	84·25	81·25	77 25
	14 Wheel 1.—No. 80 1⅛ in. Tire B	36	Aug. 27	71⅛	183	31·67	...	85·75	83 75	80·60	73·00	67 50	58 75
	15 Wheel 2.—No. 80 1⅛ in. Tire B	35	Aug. 27	71⅛	183	31·23	...	86·75	84·25	80·75	72·00	66·10	56·50
	16 Wheel 2.—No 80 1⅛ in. Tire A	41	Aug. 27	71⅛	183	33·6	...	...	83·00	79 25	71·40	66 50	58·00
	17 Wheel 5.—1⅛ in. Tire 5. 42 A	...	Sept. 1	65·7	183	30 75	..	...	..	65·75	50·25	41·75	

which the balls roll, and I can best consider this with a photomicrograph of the highly magnified fracture of the broken steel surface before us on the screen. You will then see by the marked difference in granular structure how perfectly the surface hardening has been carried out. As for the balls themselves, they are case-hardened in the same careful manner, and I give below the measures of twenty of them picked up at random to show the uniformity of manufacture:

Number of the Ball.	Measured Diameter.	Number of the Ball.	Measured Diameter.
	Inch.		Inch.
1	0·1878	11	0·1880
2	0·1881	12	0·1880
3	0·1882	13	0·1879
4	0·1880	14	0·1879
5	0·1878	15	0·1880
6	0·1880	16	0·1880
7	0·1882	17	0·1880
8	0·1878	18	0·1880
9	0·1880	19	0·1880
10	0·1880	20	0·1880

Now for the chainless bicycle—the state of the art toward which the American machine methods have been struggling for years back. Three great difficulties had to be overcome to make the venture commercially or technically successful.

First, some material which could be worked into tubes had to be found which should possess the requisite strength, lightness and resistance to torsion. This material must be worked in machinery specially designed, since no plant existed in which one inch and a half hard steel tubes could be drawn cold with the necessary precision to give their tubing at 250,000 lb. per square inch tensile strength or 150,000 lb. elastic limit. This is the condition of such tubes before annealing.

Second, while involute and epicycloidal gears had been cut on machines, such machines were far too slow, and consequently too costly, to make such gears for the bicycle in the quantities required. It remained for the two great firms of machine tool makers, the Pratt & Whitney Company, of Hartford, Conn., and the Brown & Sharpe Company, of Providence, R. I., each to bring forward compact machinery which should occupy small floor space, and at the same time automatically cut an epicycloidal or involute shaped tooth at the will of the mechanic in charge. We shall see upon the screen such machines in operation.

Third, a process was to be devised for the hardening of gears, ball and spherical cup bearings throughout, which should not, in practice, result in any appreciable deformation of the tooled surfaces.

It has been a surprise to me to find that here in England many regard the chainless wheel as something new, something radical. It is the chain that is new, not the gear. A generation before the modern bicycle was born, the mathematicians had shown theoretically that if spur or conical gear teeth were cut in certain curves, not circular, power would be transmitted with as small a loss as by any other method. No thinking American mechanic ever analyzed the chain bicycle construction without convincing himself that the compact, rigid, tightly inclosed shaft power transmission would be adopted for the bicycle whenever rigid enough frames and hard enough gears could be manufactured in a commercial way. The chainless bicycle is neither a discovery nor an invention; it is an evolution, and so far as we can now see, it will be the survival of the fittest. The use of the rigid under-strut of the rear triangle as the means of carrying the tube to which are brazed the end gears is the most elegant solution of the gear case problem yet proposed. Here you have the gear case rigid, a little over one inch in diameter, and firmly secured to the thin steel covering caps at each end. The gears may run in a cup of oil, if necessary, and the stiff under-strut thus serves the double purpose of part of the frame and gear case as well. I must bring this part of the paper to a close, leaving details to the explanation of the illustrations on the screen.

It was in 1865 that Pierre Lallement, living in the manufacturing town of Ansonia, first made an American bicycle. He rode from that town to New Haven, fourteen miles, on one; but it was not until 1877 that Col. Albert A. Pope, after riding a wheel in the Back Bay district of Boston, foresaw its possibilities and founded the great industry of which he has remained the conspicuous chief. He has been justly called the father of the American bicycle. Not that he invented any of its parts, but in the broadest sense he has steadily nurtured the bicycle art in the United States. This, what John Stuart Blackie would call virtuous energizing, has been equally prevailing, whether in the conduct of this great company or whether before State legislatures urging proper measures for good roads, or combating the restrictions of small town councils on bicycle traffic, or urging upon the technical schools and assisting financially technical education, or pushing to effective completion highly organized and contributory companies, such as the motor carriage department of the Pope Manufacturing Company. You get your peers by heritage, we must find ours by survival; and Col. Albert A. Pope, when he laid aside the soldier's uniform he had always honored, at the close of our civil war, entered upon a career which has made him respected alike by those whose business schemes he opposes or advocates, while by his men he is loved, because he has constantly regarded their welfare, and no one can complain of an unredressed grievance who had a just cause. It is men of his stamp and mould which constitute our American aristocracy, whether in literature, or pure science, or mechanical art.

The divining rod is still thought an efficient means of finding water. Witness the small English town of Porthcawl, which, according to *Nature*, has paid about $4,000 to a man who pretended he would locate springs by the use of the miraculous rod. His endeavors were fruitless, and the government ordered the members of the city council to refund to the city the amount uselessly expended.

GAS AND PETROLEUM ENGINES AT THE BRUSSELS EXHIBITION.

IT probably will interest our readers to know that the English types of both gas and petroleum engines more than held their own at the Brussels Exhibition, and that on the whole they were well and extensively represented. Eight different firms belonging to the United Kingdom contributed fifteen gas and petroleum engines, most of which worked constantly under the eyes of the visitors to the exhibition, and seven of which were actually engaged in the production of power or electric current for the various services of the show. Foreign makers, nine in number, of various nationalities, contributed nineteen engines, of whom very few were actively engaged in producing power or electric current, and were mostly smaller than those contributed by British makers, and designed for small workshops and house installations rather than for use in works or electric stations of a more important size. The total horse power of the British display was nearly 300, while that of the foreign makers was but one-third of that amount.

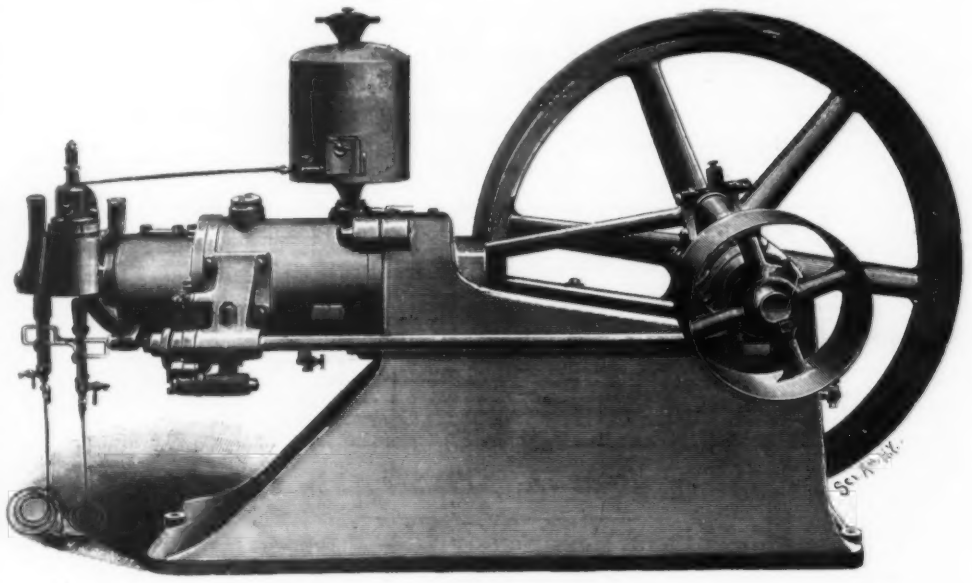


FIG. 1.

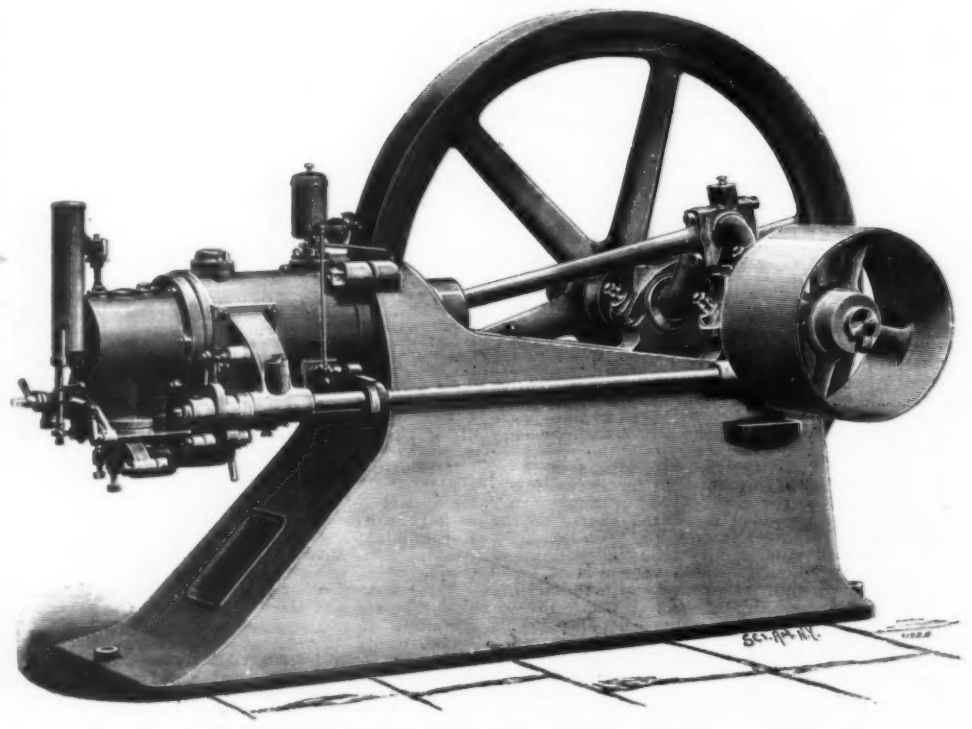


FIG. 2.

TANGYES' OIL AND GAS ENGINES AT THE BRUSSELS EXHIBITION.

Messrs. Tangyes, of Birmingham, showed four engines of 69 horse power. The largest engine was a 55 horse power gas engine, which was shown in motion, but did no useful work. This engine is nominally of 25 horse power, but is capable of giving a maximum of 55 brake horse power at a speed of 160 revolutions per minute; it is recommended for working regularly at 46 brake horse power with town's gas. The bed is carried down to the ground line, thus being specially adapted to resist vibration and rocking. Pinkney's patent combustion chamber is fitted, the object of which is to give a steady burning of the gaseous mixture during the power stroke. An efficient pressure starter is fitted to this engine, by which a charge of gas and air is pumped into a strong steel receiver, up to a suitable pressure; the charge is then let into the cylinder, the crank being in the right position for starting; the engine then moves off from the pressure thus exerted, and in so doing a trip arrangement fires the charge by means of the ordinary igniter, and the engine is started with a strong impulse. The lubricator is positive in its action, and the ignition is controlled by a mechanically worked ignition valve. Their next size engine is a 4 nominal horse power, with special governor, of the inertia type, but otherwise of the same details as the larger engines, and is used for furnishing the power for a bread-making installation of the "Complete" Bread Company. Our lower illustration shows the 4 nominal horse power gas engine with one flywheel and pulley for ordinary driving, but the one exhibited was for electric lighting, having two heavy flywheels and without pulley—the dynamo being driven by a belt from one of the flywheels. The last of the series is a 6 horse power petroleum engine, which is very simple; it is constructed on the same general lines as the gas engines of this firm, but has only two cams on the side shaft instead of four: one for the inertia governor, and one for the exhaust. Another simplification is the absence of any pump for feeding the lamp, this being fed under a head from a reservoir attached to the engine. The lamp consists of a burner surrounded by copper coil; this is heated at starting, but when once warmed, the heat produced is sufficient to produce a constant supply of petroleum vapor. The oil to supply motive power is contained in a reservoir on the cylinder and is fed automatically when the inlet valve is opened. The governing is effected by means of Pinkney's patent incline governor, which, acting through a simple arrangement of lever and catch, when the speed of the engine exceeds the normal, retains the exhaust valve open on the charging stroke; the inlet valve remaining closed, no air can be drawn through the vaporizer, thus preventing the cooling of the latter and doing away with the necessity of keeping a lamp burning continuously when running with varying loads.

The engine shown in our upper illustration is for a constant working load of 6 brake horse power, and is tested at the works to about 25 per cent. more than this. We must also remark that the working of these engines is unusually silent, and that they have attracted much favorable attention in the exhibition.—*Engineering.*

[Continued from SUPPLEMENT, No. 1149, page 18367.]

ACETYLENE AS AN ILLUMINANT.

THE apparatus of the third class, in which the calcium carbide falls into an excess of water, offer, in principle, very great advantages; but their mechanical production is somewhat difficult, and we think that the problem has not yet been completely solved.

If we throw a piece of carbide into a vessel full of water, the volume of gas disengaged will be definitely limited, and there can therefore be no overproduction. On another hand, since the decomposition of the carbide takes place in an excess of water, the heat produced by the reaction causes merely an elevation of temperature that is too feeble to affect the purity of the gas; and, as the latter, as soon as generated, has to pass through the water of the generator, it gets rid therein of all the impurities that are soluble in that liquid. An apparatus based upon this principle would therefore prove very advantageous, and, indeed, as M. Moissan says, would be the apparatus par excellence.

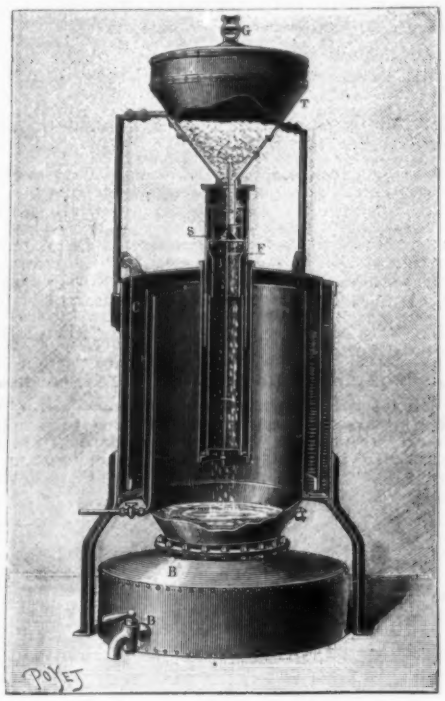


FIG. 1.—SECTION OF THE COUSIN ACETYLENE GAS GENERATOR.

The calcium carbide of commerce comes in the form of blocks of very irregular dimensions and of considerable weight. It is therefore necessary to bray it before using it. This operation is performed with some little difficulty, inasmuch as the carbide is a very hard substance and one that is easily destroyed by the moisture of the air, especially when it is reduced to powder, the surface of contact with the air being then extremely wide. The result of this braying is to increase the net cost of the substance and diminish its rendering of acetylene per unit of weight.

The majority of inventors employ the carbide in the form of powder, which they throw directly into the water. It does not seem as if this procedure ought to give entire satisfaction, because it is possible for the powdered carbide to float for a certain length of time without decomposing (especially when the water is charged with lime), and there then forms upon the surface of the liquid a somewhat resistent pellicle. The regularity of the production would therefore no longer be assured; and, besides, since the grains of carbide decompose upon the surface of the liquid, we no longer profit by the advantages of the process; that is, the automatic washing and cooling.

A solution of the problem should therefore rather be sought in the use of fragments of a weight sufficient to cause them to sink directly to the bottom of the water, or, better, in the use of agglomerated pastilles or of cartridges of carbide of regular form that a distributer would cause to fall automatically into the water. Among the apparatus in which powdered carbide is employed, we may mention the following:

(1) Those which permit of the fall of the same bulk of the substance at every maneuver of the distributer, and of which M. Mareschal's apparatus is the type (Fig. 2). The carbide receptacle is closed by a drum of which the circumference is provided with cells all of the same capacity. When the drum revolves, these cells become filled at the top and empty at the bottom into the water of the gas generator. The drum is revolved through the intermedium of a piston or of a bellows pushed on one side by a spring and on the other by the pressure of the gas in the interior of the apparatus.

The defect of apparatus of this kind is that the force brought into play by the piston for maneuvering the distributer is very feeble, since it depends upon variations in the pressure of the gas, which must in principle be very low in a good apparatus. It would be necessary to give the piston a wide surface in order to have the force brought into play adequate to overcome the friction of the distributer and piston in the cylinder.

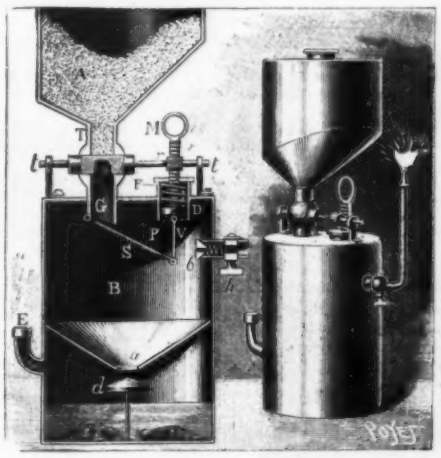


FIG. 2.—THE MARESCHAL ACETYLENE GAS GENERATOR.

(2) Other inventors prefer to allow the carbide to fall into the water in a variable quantity, proportionate at every moment to the consumption of the gas. The Claude & Hess, Thivert, Chivert, Bonneau, Leroy & Janson, Cousin & De Perrodil apparatus are based upon this principle. Fig. 1 represents the Cousin & De Perrodil apparatus.

The carbide is contained in a hopper, T, which may be recharged during the operation of the apparatus through a funnel provided with a cock, G. A conical stopper, S, maneuvered through a rod connected with the holder, C, of the gasometer, closes the hopper when the supply of gas is sufficient, and, on the contrary, allows the carbide to fall into the water reservoir, B, when the holder descends too low. A system of tubes, K, filled with water forming a hydraulic joint, assures a hermetical closing and permits of a great liberty of motion. The milk of lime formed in B is drawn off from time to time through the tube, B', which is provided with a cock. The supply of water is renewed through the tubes, K. This apparatus gives very satisfactory results.

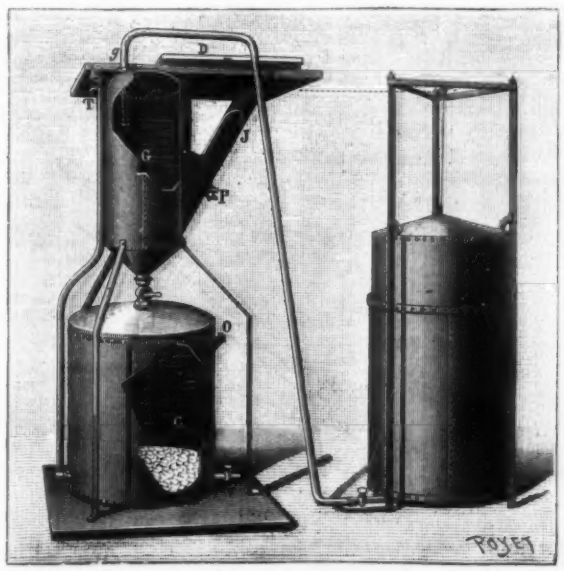


FIG. 3.—THE PATIN ACETYLENE GAS GENERATOR.

Finally, among the apparatus in which non-pulverized carbide is employed, may be mentioned that of M. O. Patin (Fig. 3). Here the carbide is contained in the compartments of a distributer, D, which is connected with the holder of the gasometer through a chain. This distributer moves in guides when the holder, in descending, carries it along. The compartments thus present themselves successively over an aperture formed in the guide. The carbide then falls through the inclined conduit, P, into the water reservoir, which consists of two chambers, G and C, communication between which may be closed by a cock, R. The lime produced by the decomposition of the carbide accumulates in the lower receptacle, whence it may be removed through the cock, V. In order to effect such cleaning, the cock, R, is first closed and the plug, A, removed. The cock, V, is then closed and the receptacle, C, filled with water until the liquid overflows at A. Then the plug is put in place and the cock, R, is opened.

The cleaning is therefore done without any escape of gas and without the introduction of any air into the apparatus. The production of gas is not arrested by this operation, since the upper chamber, G, is always in service.

In order to prevent the carbide from decomposing as soon as it enters the conduit, P, the latter is filled with kerosene, which has no action upon it, and which, being of less density than water, remains upon the surface. The carbide, moreover, is itself saturated with kerosene before being put in place in the distributer in order to retard the decomposing action of the moisture of the atmosphere.

The gas produced ascends to the upper part of the chamber, G, and flows thence to the gasometer. It cannot escape into the air through the conduit, P, notwithstanding the latter is open at the top, because the weight of the column of liquid that it contains prevents it from doing so. The manner in which the carbide is renewed at D is evident.

In conclusion, we cannot too strongly advise our readers to use prudence in the selection of an acetylene gas generator. An apparatus defective in its principle or in its construction is the greatest source of danger that the use of acetylene offers. Ignorant or imprudent inventors, and manufacturers who are not very conscientious, have alone contributed toward giving so bad a reputation to the new gas. For the illustrations and the above particulars we are indebted to La Nature.

NATIONAL DEBTS.

AN English journal, The Daily Mail, has recently published an article upon the comparative public debts of the principal countries of Europe (exclusive of Turkey and Spain) and of the United States of America. The combined debts of these nations, eight in number, amount to the formidable figure of $23,750,000,000. As may be seen from Fig. 1, France occupies a unique and not very enviable situation in the mountain chain of debts. It not only holds the first rank, but exceeds in large proportions the countries that have the heaviest burdens to bear. After it comes Russia, which, since less than a century, has contracted a debt greater than that of England.

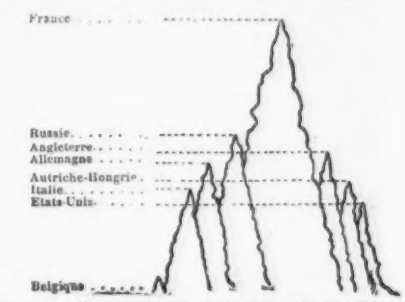


FIG. 1.—MOUNTAIN CHAIN OF NATIONAL DEBTS.

France	$6,261,672,000	Austria-Hungary	$2,748,624,000
Russia	3,673,713,600	Italy	2,472,972,400
England	3,253,158,000	United States	2,072,439,000
Germany	3,019,255,400	Belgium	455,238,800

FIG. 2.—COMPARATIVE BURDEN OF THE INDIVIDUAL TAX.

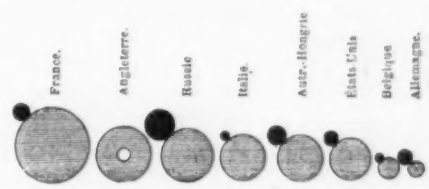


FIG. 3.—INCREASE AND DECREASE OF THE NATIONAL DEBTS DURING THE LAST FIVE YEARS.

France has a debt of $6,261,672,000, which is $1,000,000,000 more than that of England, $2,500,000,000 more than that of Germany, $3,500,000,000 more than that of Russia, and $4,000,000,000 more than that of the United States. Its debt is more than double that of Austria-Hungary, Italy, and the United States, and more than thirteen times that of Belgium.

In Fig. 2 is startlingly shown the comparative burden that every citizen of the eight states has to carry. The burden of one Frenchman is equal to the combined burdens of one Englishman and one Italian, and the combined debts of the citizens of Austria-Hungary, Germany, Russia and Belgium very slightly exceed the debt of one inhabitant of France.

In the last figure may be seen the increase or decrease in the public debt during the last five years.

The dimensions of the largest circle show the volume of the debts, five years ago, of each country cited, while the smallest (black) circle shows the amount of increase during these five years. Among the eight nations, the United Kingdom alone has succeeded in diminishing its debt. The amount of such diminution

is shown by the white dot situated in the center of the circle. The imperial debt of Germany and the federal debt of the United States are alone taken into consideration in this figure.

There is another manner of looking at this latter question. In taking the total amount of the increase and decrease of the national debts during the last five years, and dividing it by the number of days of this period, we reach the following result:

For the last five years, the public debt of the United Kingdom has daily diminished by $97,440.

For the last five years, the daily increase in the public debt of the seven other countries has been as follows:

Italy	$20,745
Belgium	25,005
France	121,175
United States	126,371
Germany	140,695
Austria-Hungary	179,935
Russia	421,110

[Continued from SUPPLEMENT, No. 1149, page 18362.]

A PHOTOGRAPHIC IMPACT TESTING MACHINE FOR MEASURING THE VARYING INTENSITY OF AN IMPULSIVE FORCE.*

By B. W. DUNN, Lieut. Ordnance Department, U. S. Army.

FIG. 8 shows a reduced reproduction of one of the impact curves.

In this case a 33·109 pound weight fell 15 inches and produced a permanent compression of 0·1658 inch in copper specimen. The time consumed in producing this compression was 0·0030317 second.

USE OF IMPACT CURVE.

To make the impact curve, Fig. 8, available for calculating a table to give the resistance, in pounds, for any given compression of copper cylinder in inches, it is necessary to know the rate of fork and the relation between any given ordinate of the curve and the compression of specimen. Photography was used to obtain this information, but space does not permit a detailed description † of methods adopted. The fork was calibrated by securing its record on a long photographic plate falling freely under action of gravity, and the variable ratio of ordinate to compression was determined from a series of "scale negatives" made by moving the piston down one-thousandth of an inch at a time and recording photographically the corresponding positions of "sun image."

With an instrument reading accurately to 0·00001 meter, a number of sets of ordinates, the individual ordinates in each set being separated by a constant and a small interval of time, Δt, were then measured and tabulated. The first differences of these ordinates measure the rate of compression, or velocity of falling

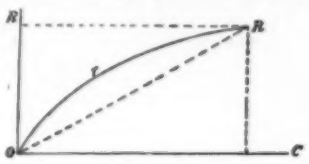


FIG. 12.

weight after impact, and a curve can be constructed showing this velocity as a function of either time or compression. Each "set" of ordinates gives a set of points in this curve, and it is evident that we may obtain as many points as desired.

Fig. 9 shows a velocity curve constructed in this way for one of the negatives.

This curve was plotted on a very large scale, and the mean curve, assumed to be the true one, was easily drawn.

The true impact velocity and the initial tangent to curve are known from the height of fall of the weight, W.

The steel piston is at rest at the instant of impact, and requires some time to acquire the velocity of W. For this reason the initial measured velocities of piston are lower than the theoretical velocities of W, and the vibrations produced in apparatus by the shock from impact cause slight irregularities in the measured values.

These irregularities are practically eliminated by the adjusted curve, and they do not appear during the final stages of compression. Since our main object is to obtain a reliable dynamic measure of the maximum resistance of specimen, the slight irregularities in measured data for the earlier stages are of little consequence.

After adjusting our tabulated "first differences" by the mean velocity curve, Fig. 9, we form another table showing "second differences" as a function of time, and use these data to plot the "retardation curve," Fig. 10. We know the initial and terminal tangents to the true retardation curve, and can readily draw the mean curve.

The analytical expression for the resistance, R, which, working over the path of compression, C, absorbs the kinetic energy in weight, W, is

$$R = -\left[\frac{W}{g}\frac{d^2 c}{d\ t^2} + W\right]$$

The ordinates of the retardation curve, Fig. 10, represent the variable factor

$$\frac{a^2\ c}{d\ t^2}$$

By plotting, as a function of the compression, the values of R, obtained in this way, we obtain the dynamic resistance curve shown broken in Fig. 11.

For comparison, the same figure shows the resistance curve obtained from static testing machine data.

The difference between them represents the effect of the neglected "time element" or the error of "static tarage" when the total time consumed in producing the compression is about 0·003 second. This error will vary with the time, and it should also vary largely with the mass of specimen. The civil engineer who uses massive pieces to sustain impulsive forces is, therefore, interested in a further pursuit of investigations of this nature.

EMPIRICAL FORMULA FOR MAXIMUM RESISTANCE.

The foregoing sketch gives but a meager idea of the labor involved in using an impact curve to calculate the varying pressure produced by a blow. To secure the original measured data from the photograph requires time, patience and a high order of skill in making fine measurements. The successive adjustments of data and the final calculations introduce further complications and restrict investigations of this nature to the field of laboratory research.

To be of practical value to the civil engineer this process must be simplified and abridged, so that within a short time after striking his blow the investigator may announce the maximum stress developed as well as the resulting strain. A very simple formula obtained by combining observed facts and theoretical deductions promises the desired relief.

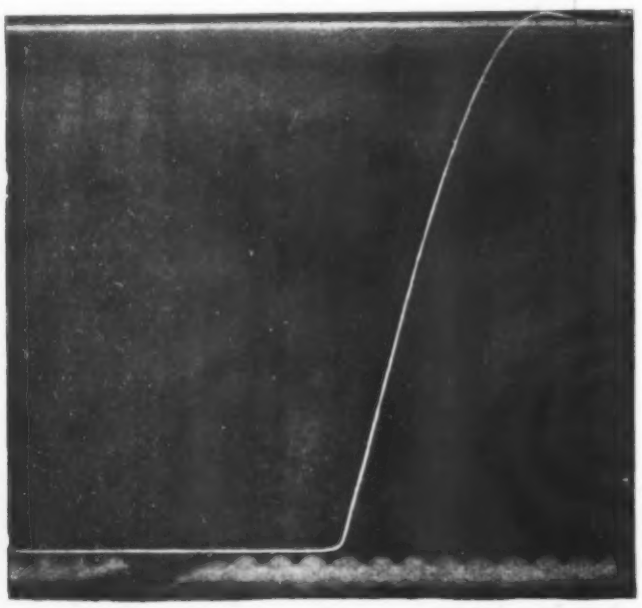


FIG. 8.

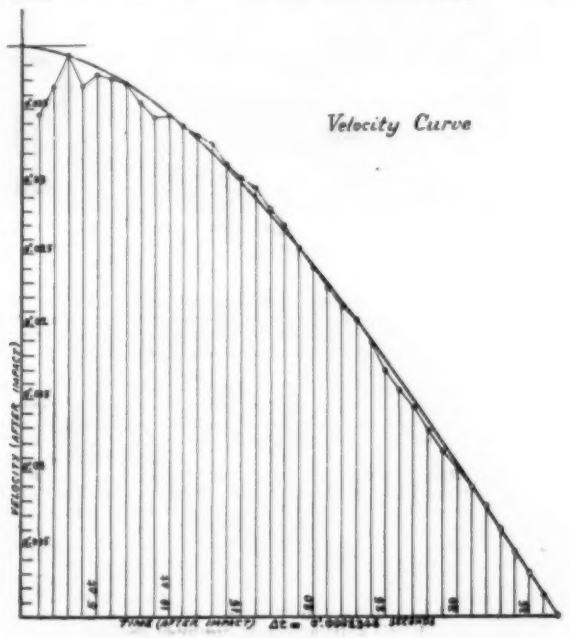


FIG. 9.

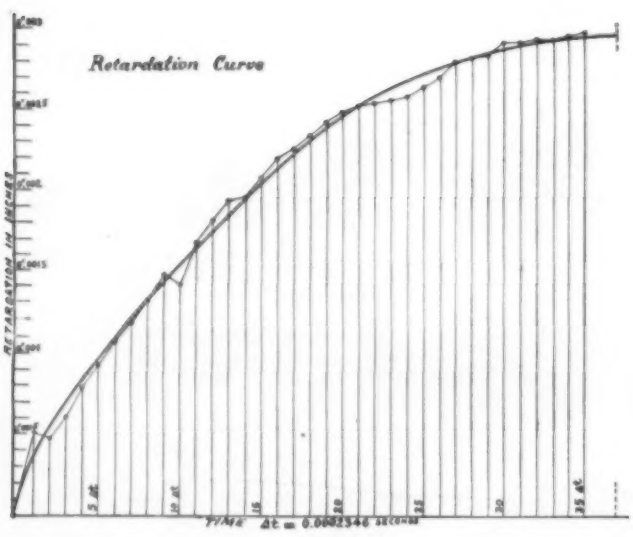


FIG. 10.

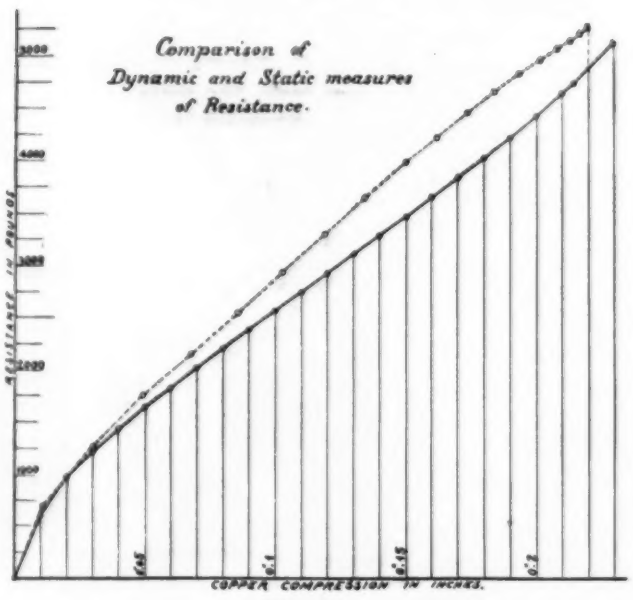


FIG. 11.

* Paper recommended by the Franklin Institute for the award of the John Scott Legacy Medal and Premium. From Journal of Franklin Institute.

† Detailed descriptions are given in "Notes on the Construction of Ordnance," No. 71, Government Printing Office, Washington, D. C.

This formula is

$$R = \frac{A\,M\,V}{T}$$

in which

R = maximum stress developed in a rigidly supported specimen by a blow.

M V = quantity of motion in striking mass at instant of impact.

T = total duration of blow.

A = a coefficient whose limiting values are

1·57 +

and unity. The value of this coefficient for a given blow will depend upon T and the material of specimen.

A brief outline of the study which furnished this formula is necessary to a thorough understanding of its utility.

In Fig. 12 let the ordinates be resistances and the abscissas compressions.

Let us assume, first, that the resistance increases directly with the compression, and that its initial value is zero. A right line, o R, will then represent the resistance curve. Under this assumption the relation of velocities of striking weight after impact to corresponding compressions will be that of the ordinates of an ellipse to the corresponding abscissas.

On the other hand, let us assume the resistance as constant. A right line, such as R R, parallel to axis of compressions, will then represent the resistance curve, and the relation of velocities to compressions will be that of the ordinates of a parabola to the corresponding abscissas.

The middle curve in Fig. 13 is the adjusted velocity curve of negative No. 22, plotted accurately as a function of compression. The upper curve is an ellipse and the lower one is a parabola, both constructed to pass through the initial and final points of the true velocity curve.

Since the true velocity curve, Fig. 13, lies between the ellipse and the parabola, we see that the true resistance curve will be some such curve as O r R, Fig. 12, and that the right lines, o R and R R, corresponding respectively to the ellipse and to the parabola, Fig. 13, will be the limits.

The equation of the impact curve, as a whole, has not been determined. It can be represented by the equation,

$$t^2 = x\,c,$$

a parabola with a variable latus rectum.

By selecting three points in impact curve, each separated by Δ t, we can cause a parabola to pass through them and have its axes parallel to axes of impact curve.

Fig 14 shows two such parabolas.

That parabola whose axis coincides with the maximum ordinate of impact curve is called the limiting parabola.

If the equation of limiting parabola be

$$l^2 = a\,c, \qquad (1)$$

the value of maximum resistance, R (neglecting gravity), will be

$$R = \frac{M\,d^2c}{d\,t^2} = \frac{2\,M}{a} \qquad (2)$$

By substituting in (1) T, total duration of blow, for t, and calling the resulting value of c, C m, we have

$$C\,m = \frac{T^2}{a} \qquad (3)$$

The work, W', that the constant force, R, equation (2), is capable of performing during the time T is

$$W' = R\,C\,m \qquad (4)$$

The actual work, W, done during the time, T, by the resistance of specimen is

$$W = \frac{M\,V^2}{2} \qquad (5)$$

It was observed that the values of W'—obtained from the different negatives by causing a parabola to pass through three consecutive points near the vertex of the impact curve, and substituting in (4) the value of a, given by the equation of such a parabola—could, without sensible error, be assumed as equal to just twice W.

Substituting 2 W, or M V^2, for W' in (4) and the value of C m given by (2) and (3), we have

$$R = \frac{\sqrt{2}\,M\,V}{T} \qquad (6)$$

For values of T between 0·003 and 0·004 second, and for specimens of pure annealed copper, subjected to compressive stresses, we may substitute, then, $\sqrt{2}$ for the coefficient, A, in the general formula,

$$R = \frac{A\,M\,V}{T}$$

In the report referred to, Ordnance Construction Note No. 71, it is shown that the limiting values of A are 1·57 + and unity. For such a slowly changing function, a few points, determined just as one point has been determined for copper by this investigation, will permit the accurate construction of curves showing, for different materials, the values of A as a function of T.

With tables constructed from these curves, it will be necessary, in testing a given specimen, to measure only the value of T. A table will give the value of A, the known mass and height of fall of striking weight will give the product M V, and the maximum resistance, R, can be stated shortly after delivery of blow. An impact curve will not be necessary in practical testing, since micrometer measurements before and after the blow will show the effect on specimen. The apparatus herein described will then be simplified and will become a chronograph pure and simple. The interval of time to be measured, T, is readily connected with the making and breaking of an electric current. With the striking weight as one pole and the specimen, or piston resting on it, as another, the current will be made at the instant of impact and broken by rebound.

The foundation for any accurate chronograph must be a refined time scale, such as had to be provided for this investigation. As soon as this time scale was obtained, it was seen that a photochronograph for general use, especially in ordnance work, was available. It remained only to provide means for causing light signals to mark the beginning and the ending of the time interval to be measured. The simplest and most economical device for this purpose was the Ruhmkorf induction coil, and in 1891–92 a chronograph was designed by the writer and constructed by the Ordnance Department, United States Army, wherein the secondary sparks were photographed simultaneously with the time scale and gave the desired signals.

Fig. 15 is a reproduction of a record from this chronograph, which shows the times occupied by a projectile in passing over successive intervals of 2 feet.

A theoretical objection to the use of the Ruhmkorf coil is found in the fact that the secondary spark is not produced simultaneously with the break in primary circuit; but when we require two successive sparks and have a uniform time scale, even the slight errors due to this delayed action can be made to balance each other.

Fig. 16 reproduces another chronograph record wherein the duration of secondary spark is made practically instantaneous and a fine shadow line is placed in each spark record. These shadow lines are of great assistance in obtaining accurate measurements from the photographs.

Some years after the construction of this photochronograph, two other investigators, working independently of the writer, produced an instrument involving a new method of securing the light signals.*

This highly ingenious and original method reduces materially the delayed action above mentioned, but it does not seem possible to procure with it the well defined limits for use in measuring given by shadow lines in spark records, Fig. 16.

With chronographs available for measuring T with the required accuracy, the outlook for a practicable and a reliable "impact testing machine" seems promising.

One other possible simplification remains to be mentioned.

It will be remarked that in the general formula for R,

$$R = \frac{A\,M\,V}{T}$$

the second factor expresses the mean resistance of specimen. Another expression for this mean resistance is obtained by dividing the energy in striking mass by the path.

It may be found more convenient and more expeditious to measure the path rather than the time. In this case it will be necessary to determine A as a function of the height of fall of striking mass. This may or may not be possible. If so, the use of photography, and the consequent complications and delays—due to necessity for operating in a dark room, to time required for development, etc.—may be avoided.

CONCLUSION.

The measurement of intensities of impulsive forces is of general interest to the scientific world and of special interest to the engineering profession.

It is suggested that in some thoroughly equipped laboratory an extension of the investigation herein described should be made.

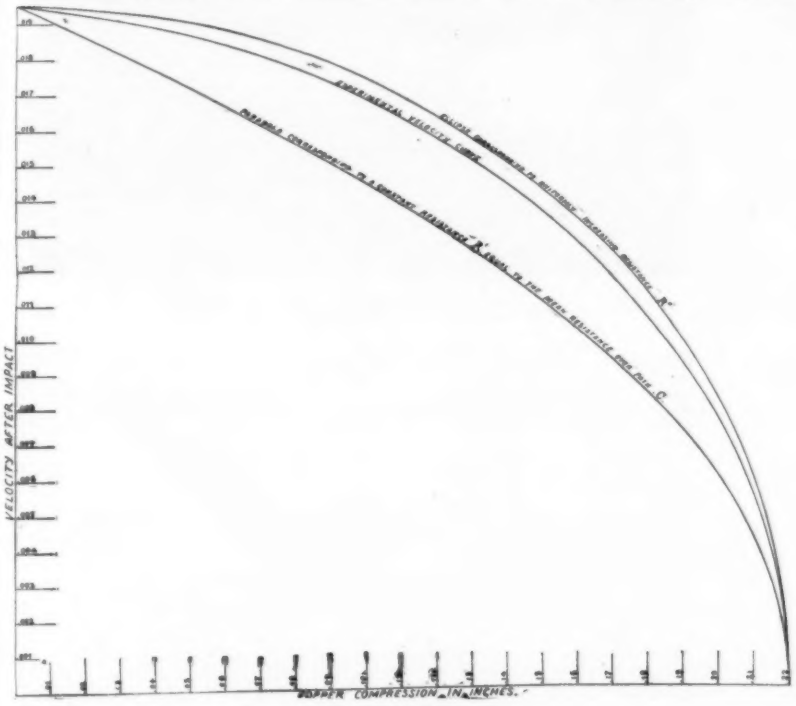


FIG. 13.

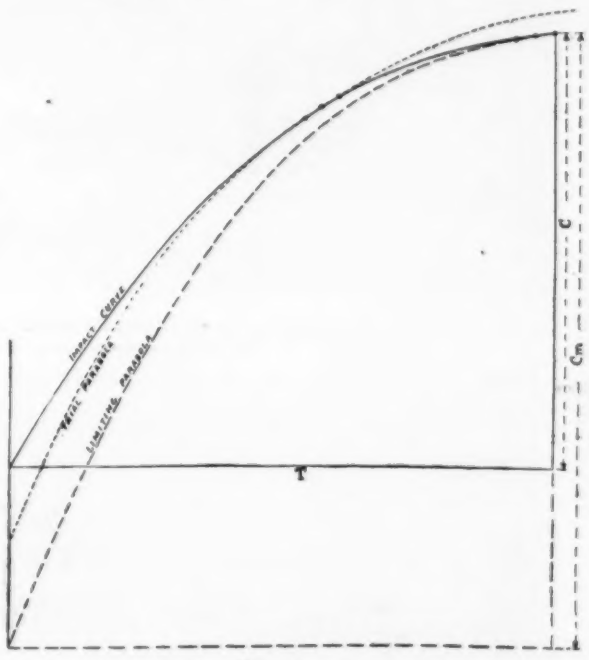


FIG. 14.

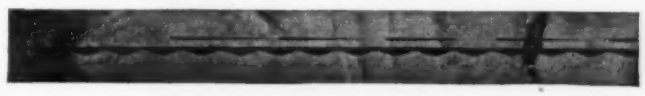


FIG. 15.

FIG. 16.

Twenty bicyclists having been killed during the past year on a bridge at a sharp turn at the bottom of a hill on the road between Mentone and Nice, a netting has been put up at the dangerous point by the Touring Club of France, to catch reckless coasters who are hurled over the parapet.

*See article on "Polarizing Photochronograph," by Dr. Crehore and Lieut. Squier, United States Army, in Journal of the United States Artillery, vol. vi, No. 3, also SCIENTIFIC AMERICAN SUPPLEMENT, January 2, 1897.

[Continued from SUPPLEMENT, No. 1149, page 18370.]

GLIDING EXPERIMENTS.*

FIG. 8 exhibits the next full-sized machine which was built. It is seen to be very simple in construction and to consist in a single intersection Pratt truss carrying the surfaces, to which was applied a regulating mechanism designed by Mr. Herring. This truss will safely support 300 or 400 pounds applied to the arm bars at the center. In calculating its proportions, a basis has to be adopted which is the reverse of that which obtains in the calculation of bridges, for the support or air pressure has to be considered as uniformly distributed, and the load has to be figured out as concentrated at the center. It may be mentioned in this connection that one practical difficulty found has been in devising some method of adjustable connection between the vertical posts and the diagonal ties. The latter are from two to five hundredths of an inch in diameter, and it is not practicable either to cut a screw upon them for a nut or to apply a sleeve nut or a turnbuckle. Perhaps some engineer will suggest a better device than the loop heretofore used, which is made by twisting the wire back upon itself, and which is not adjustable.

With this apparatus, as shown in Fig. 9, several hundred glides were made, varying in length from 150 to 360 feet, at angles of descent of 7½ to 10 degrees, and during the six weeks occupied with the experiments not the slightest accident occurred either to the operators or to the machines. The regulating mechanism took care of the equilibrium fore and aft and diminished the effect of the side wind gusts, which were then easily overcome by slight side movements of the operator. Toward the last, amateurs were permitted to try it under instructions. They made fair glides in safety. One or two cruises by newspaper reporters and another by a novice, who was picked up by the wind and raised some forty feet into the air, but who landed almost in his tracks as gently as if he had only fallen from the height of a chair.

Fig. 10 shows a side view of this apparatus in flight. On this occasion a glide was made of about 300 feet at a height of 10 to 20 feet above the ground, but it was not uncommon for the machine to sail 40 or 50 feet above the ground and to pass over the heads of the spectators. The whole apparatus spread 134 square feet of supporting surface, weighed 23 pounds and thoroughly supported the weight of a man at speeds of about 23 miles an hour. A piece of trestle work will be observed in the background. This was used to launch the machine which is next to be described.

Fig. 11 exhibits the fifth full-sized apparatus which was experimented with in 1896. It was the invention of a Russian, who claimed that he had already attained success in soaring flight with it, and as this closely resembled the machine of Capt. Le Bris, who was said to have sailed with such a machine in France, in 1867, it was determined to give the design a trial. It was a somewhat complicated apparatus. Over the top was an aeroplane, below which two great wings extended, 40 feet across, and beneath which again there was a boatlike frame which could be transformed into a skiff by inclosing it with oiled canvas. The whole spread of supporting surface was 266 square feet and it weighed 190 pounds. As this could not, like the other

FIG. 8.—TWO-SURFACED MACHINE WITH SIDE KEELS.

FIG. 11.—THE ALBATROSS MACHINE.

FIG. 9.—TWO-SURFACED MACHINE JUST STARTING.

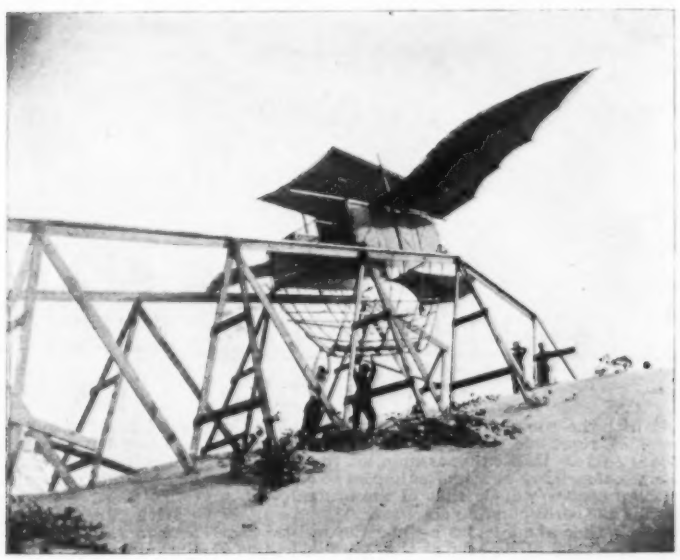


FIG. 12.—THE ALBATROSS ON THE WAYS.

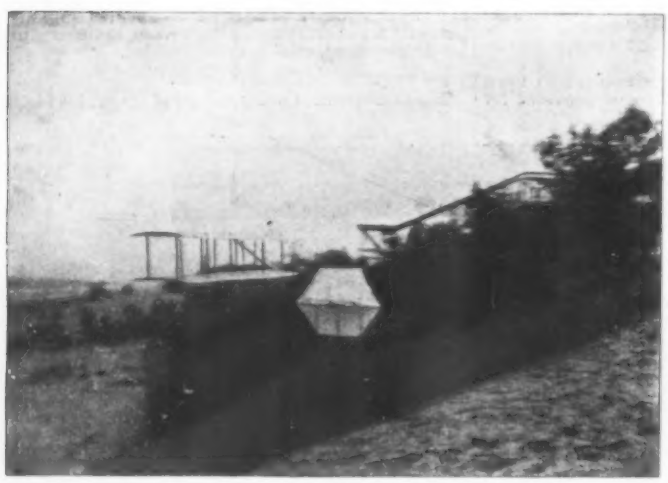


FIG. 10.—UNDER WAY AND LEVEL WITH THE STARTING POINT.

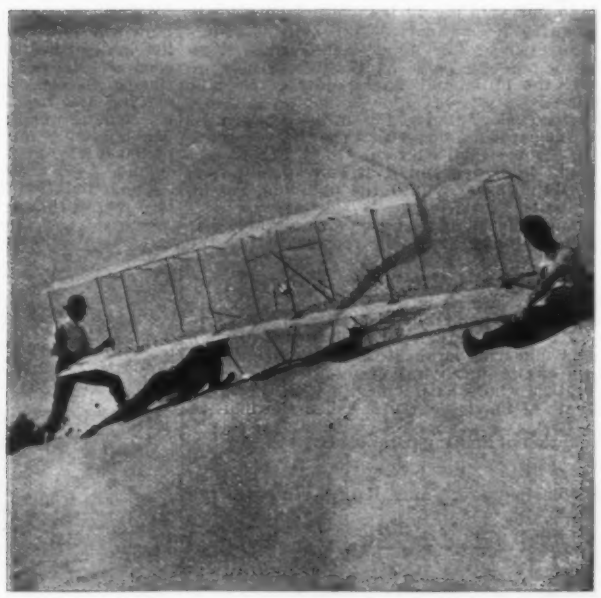


FIG. 13.—GETTING READY.

* An address by Octave Chanute, C.E., Mem. W. S. E., delivered before the Western Society of Engineers, October 20, 1897, and published in the Journal of the Society.

machines, be carried about on a man's shoulders, special appliances were required to launch it.

This appliance is exhibited by Fig. 12, and consisted of trestle work built down the slope of the hill. It involved the great disadvantage that it could only be used when the wind blew straight up the trestle, a rare occurrence. Nevertheless two launches were made, but in ballast, as there was no absolute certainty about the equilibrium. On the first occasion, with 130 pounds of ballast, it went off very well indeed, but did not sail very far. In alighting, some of the ribs of the boat frame were cracked, but were replaced in an hour. On the second trial, with 90 pounds of ballast, but in a quartering, unfavorable wind, the latter swung the machine around, after it left the ways, and upon one of the wings striking a tree, the apparatus fell and was broken. On neither occasion would the operator have been hurt had he been in the machine, but it was evidently much too heavy and too cumbrous to be successfully used in experiments designed solely to work out the problem of equilibrium.

This ended the experiments of 1896. A fuller account will be found in the "Aeronautical Annual" for 1897, edited by Mr. James Means, of Boston, whose publications during the last three years have done very much toward advancing the study and solution of the problem of aviation. Detailed plans of the multiple wing machine will be found in the 1897 issue.

The results of these experiments in 1896 were to develop two machines which are believed to be safer than any others previously tried. To advance materially the solution of the problem of equilibrium. To learn much about the management of flying apparatus in the wind, and to determine with some accuracy the power required. For this purpose the lengths and heights of some of the flights were measured. They were also timed, and it was found that the power expended was from 619 to 789 foot pounds per second, or 1·13 to 1·43 horse power to sustain 178 pounds in the air. This, however, was in a rising trend of wind. In nearly calm air the power expended was found to be two horse power, or at the rate of 89 pounds sustained per horse power. This represented the actual thrust required to be exerted by a propeller. If we assume the latter to possess only an efficiency of 70 per cent., then we should require 2·85 actual horse power on the shaft, and if the internal friction of the engine diminished its efficiency to 70 per cent. of its indicated horse power, then a motor of about five indicated horse power might be expected to maintain an apparatus of the above type, carrying a man in horizontal flight through the air. A result which is surely encouraging.

Mr. Chanute continued by saying that in 1897 he had inaugurated experiments with models for the purpose of testing still a third method of obtaining automatic equilibrium, but that these had not proceeded very far. That Mr. Herring, having been requested by an amateur to supply him with a gliding machine, had built a new one with his regulating mechanism, and that the pictures next to be shown had all been taken from flights made with that apparatus, it having been tested at Dune Park in September, 1897.

Fig. 13 exhibits the machine at the top of the hill preparatory to making a glide. It is a common saying that a child must creep before he learns to walk, and something of the same required training obtains with a flying machine. The operator (Mr. Herring in this instance) is seen creeping under the machine in order to rise with it, when lifted up by the two assistants, and to place himself within the arm bars.

FIG. 14.—POISED FOR FLIGHT.

FIG. 15.—THE FLIGHT BEGUN.

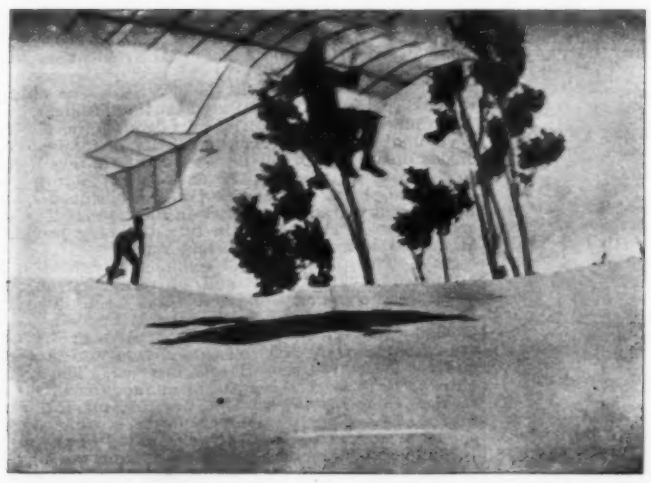


FIG. 16.—WELL UP.

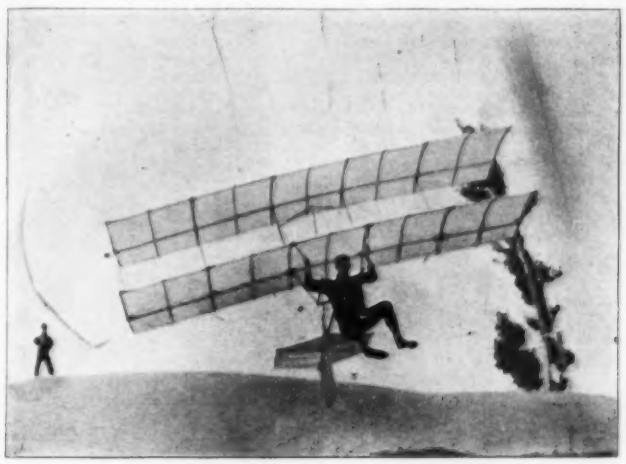


FIG. 17.—STRUCK BY A SIDE GUST.

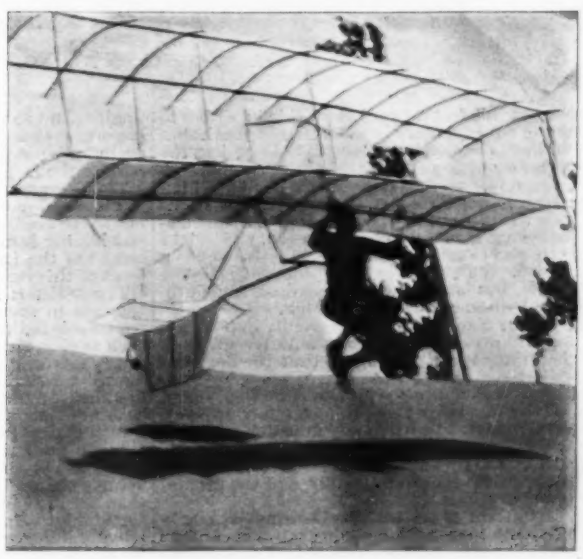


FIG. 18.—RIGHTED AGAIN.

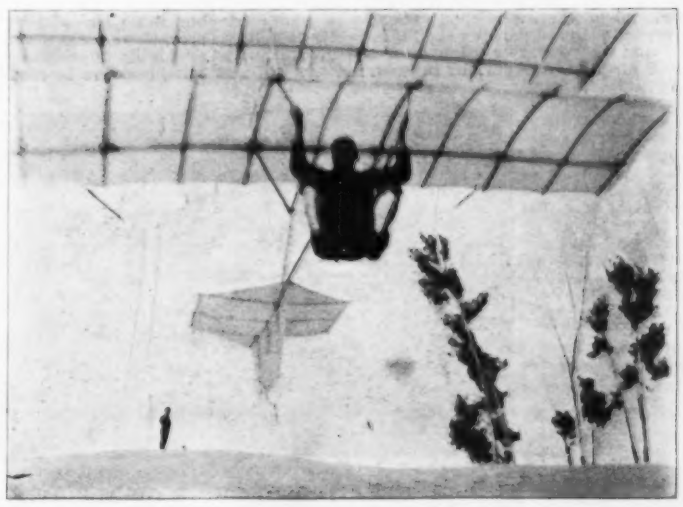


FIG. 19.—PASSING OVERHEAD.

Fig. 14 shows the apparatus poised in the wind. This involves generally a struggle with the breeze, which buffets the surfaces either from one side or the other, or fore and aft. A skillful operator resists this by bracing the machine against his back and keeping the front edge depressed, facing the wind accurately. As soon as this poise has been obtained, two or three running steps are taken, the front edge is slightly raised, and a leap is taken forward.

Fig. 15 shows the result, which is that the man is lifted up and supported by the air, and then sails forward at a slightly descending angle, the motive power being furnished by gravity, and the supporting power, which is due to the speed, being assisted by the adverse wind.

Fig. 16 exhibits the machine as thoroughly under way, the regulating mechanism providing for the fore and aft equilibrium, which is the most precarious and productive of accidents. If the wind be steady, and the operator has placed himself at just the right point within the arm bars, the glide might continue without any movement on the man's part, but there are incidents which are apt to occur in consequence of the irregularity of the wind, such as that shown in the next picture.

In Fig. 17 the apparatus is shown as struck by a side gust. The illustration in this particular picture was somewhat exaggerated by the fact that the camera was not held quite level, but it is clear that the left wing has been raised by the gust, and that the operator has thrown his feet toward that side in order to bring the wing down. It may be well here to remark that when in flight the bodily movements should be just the reverse of those which are instinctively made if standing on the ground. In the latter case, if one finds himself going over in one direction, the foot on that side is instinctively thrown out to that side; on a flying machine, if one wing is found to be depressed, the weight should be thrown to the opposite side, in order to bring the wing down. This requires some practice to become second nature, but after awhile it is done semiautomatically, and without stopping to think.

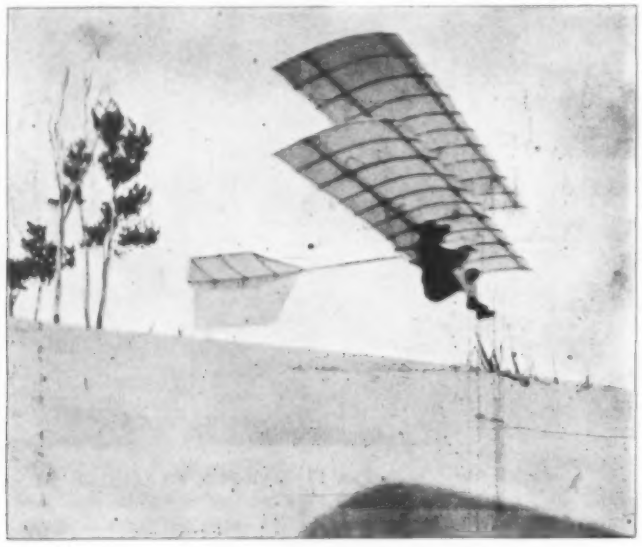


FIG. 20.—SAILING ALONG.

In Fig. 18 the machine has been righted up and is gliding forward on an even keel at a flatter angle of descent than the slope of the hill, so that the next picture shows increased height.

In Fig. 19 it is seen directly overhead of the camera and thoroughly under control, the legs having been raised up ready to be thrown in any direction to do the steering.

In Fig. 20 the trees have been passed for some distance, the apparatus is sailing steadily, and the ground is being gradually approached.

In Fig. 21 the foot of the hill has been nearly reached, and it is time to think of alighting. This is very easily accomplished by pushing the weight of the body backward on the supporting bars, through a movement of the forearms. The effect of this is to raise the front edge of the machine, thus increasing the angle of incidence and the consequent air pressure. This stops the speed, and as the diminished velocity also diminishes the pressure, the apparatus oscillates gently to a level keel, and the operator alights on the ground with almost no jar. The curious in such matters will see this maneuver performed thousands of times a day by the sparrows in the street. Mr. Herring and Mr. Avery, who were the experts who operated this machine at Dune Park, seldom or never struck the ground with greater force than would have been produced by jumping down one or two feet, and even when racing no sprained ankles occurred.

FIG. 21.—TIME TO THINK OF ALIGHTING.

(To be continued.)

A Missal, a Book of Hours, and a Psalter, which had been in the possession of Viscount Arbuthnot's family for 400 years, were recently sold at auction in London for $6,000. The Missal is the only one extant, according to the Scottish use. The manuscripts were written and decorated by his vicar for Sir Robert Arbuthnot between 1482 and 1491.

THE MINERAL STATISTICS FOR 1897.*

THE Engineering and Mining Journal is again able to furnish on the very first day of the year the statistics of production of all the minerals and metals in the United States in the year just closed, and the production of gold in the whole world during the same period. These few small tables embody many months of work, for the statistics have been collected with the utmost care, many of them by monthly or quarterly returns, and at the end the latest figures have been secured by hundreds of special telegrams to important producers all over the continent.

A special cable report received by us from the Transvaal on the 30th December brings the statistics of that producer up to the end of the year, and is all the more important because it shows how nearly equal in gold output are now the United States and this great South African rival.

This prompt publication of accurate statistics of mineral and metal production for a whole continent has never been attempted except by The Engineering and Mining Journal, for no other paper and no government has the facilities for the successful accomplishment of this stupendous work.

The statistics here given where not actually final, as they are in some cases, are accurate within narrow, reasonable limits; only in the case of a few subjects, such as clay, natural gas, some kinds of stone, lime and a very few comparatively unimportant minerals are the figures given based on insufficient returns to insure practical accuracy, and even in these the estimates used were made by those practically engaged in the industry of that particular mineral.

These preliminary statistics, as finally revised, will be published a few months later in the forthcoming volume of the "Mineral Industry," with fuller details than are here possible, and with technical articles of the highest value relating to every department of the mineral industry. Thus we provide on the one hand for the urgent needs of business and on the other for the requirements of statisticians, engineers, metallurgists and statesmen.

The value of the mineral and metal production of the United States in 1897 reached a total as given in our table herewith of $762,061,106. From this, however, there are a few deductions to be made for unavoidable duplications, such as coal used in making coke, iron ore in making pig iron, and the like, but these are not very large. On the other hand, the production of alum, amounting to about $2,500,000, and nickel, a small item, have not been included in the general table. Though the market prices of most substances were lower than in 1896, the average prices for the year were below those now ruling. It must be remembered also that the values given are of the products in their crudest forms—coal as it comes from the mine, coke from the oven, pig iron from the furnace, copper in ingots, lead in pigs, etc.—and no account is taken, even in the more simple forms of labor and other costs expended in putting these products into steel, plates or other merchantable forms.

* For the table and the article we are indebted to the courtesy of the editor of The Engineering and Mining Journal. It will be subject to slight corrections.

The aggregate value of the mineral production of the United States greatly exceeds that of any other country; in fact, nearly equals the value of the output of all Europe. And that, notwithstanding the fact that the United States has been passing through a period of unexampled depression in business, and all Europe has had a year of almost unexampled prosperity.

The production of 1897 again emphasizes not only the great total value, but the immense variety of the mineral production of the United States. Not only is this country the largest producer of iron and steel, of copper, of lead, of silver and of gold, but almost every mineral and metal known to commerce is found within our borders, and is mined or prepared in some quantity.

The mineral production of 1897 a[illegible] establishes a record, but from present indication[s] [illegible]xceeded during the year which is just openi[ng].

We give below, in condensed form, notes on the varied mineral products. These are supplemented by longer articles for all the products of importance.

Abrasives.—The production of carborundum in 1897 was 621 short tons, of corundum 230 short tons, of emery 1,500 short tons, of garnet 4,000 short tons, of grindstones 37,200 short tons, of tripoli and infusorial earth 2,862 short tons, and of whetstone, etc., $80,220. There was a considerable increase in the production of grindstones, garnet, tripoli and carborundum; a decrease in the other substances included under this classification.

Aluminum.—The production of aluminum in 1897 was 4,000,000 pounds, valued at $1,542,240, against 1,300,000 pounds, valued at $520,000, in 1896. The increase in production was due partly to the reduction in price for the metal and partly to the development of a greatly increased export trade.

Antimony.—The production of antimony was 750 short tons, valued at $78,000, against 613 short tons, valued at $63,773, in 1896. This was produced chiefly from imported ores, although the production of domestic ores increased from 150 tons to 500 tons.

Asbestos, Soapstone and Talc.—There was a production of 770 short tons of asbestos, 7,200 tons of soapstone, 9,375 tons of common talc and 32,420 tons of fibrous talc. These figures were respectively about the same as for 1896, with the exception of fibrous talc, which showed a falling off of nearly 30 per cent.

Asphaltum.—There was, in 1897, a production of 20,800 short tons of asphaltum proper, all of which came from California; 2,390 short tons of asphaltic limestone, dug in Utah and the Indian Territory, and 37,000 short tons of bituminous sandstones, which was produced in Kentucky and California, chiefly in the latter. There was a large falling off in the output of asphaltic limestone and bituminous sandstone. That of asphaltum remained about the same as in the previous year.

Barytes.—The production was 27,316 short tons, against 21,900 short tons in the previous year. The increase was due partly to the improvement in industrial conditions and partly to the exclusion of imported mineral by the new tariff law.

Bauxite.—The production increased from 17,096 long tons to 18,000 long tons. In each year the greater part of the output was made in Alabama, the remainder coming from Georgia. A noteworthy feature of this industry in 1897 was the beginning of an export trade.

Borax.—The production increased from 15,258,014 pounds to 18,000,000 pounds, derived entirely from California and Nevada. This industry is controlled by the Pacific Coast Borax Company.

Bromine.—The production decreased from 550,285 pounds to 487,149 pounds. These figures include the bromine contained in the crude bromides manufactured. The bromine industry is carried on in Ohio, West Virginia and Michigan.

Calcium Carbide.—The manufacture of this substance, which was begun in the United States only in 1896, increased from 860 short tons in that year to 1,925 short tons in 1897. The value of the output in the latter year was $134,750. In both years a large part of the output was exported.

Cement.—The production of natural hydraulic cement was 7,721,215 barrels of 300 pounds, a small increase over 1896; the make of Portland cement amounted to 2,100,000 barrels, about twice that of the previous year. The great increase in the latter was due chiefly to the displacement of imported Portland cement.

Chrome Ore.—This article, mined in California, has been unable to stand the competition of foreign ores, chiefly on account of the higher freight charges it has to pay to get to market; the entire manufacturing of bichromate being confined to two establishments, one in Philadelphia and the other in Baltimore. The increasing use of chrome ore in furnace lining promises an increasing market for this material.

Clay.—The production of common clay in 1897 is estimated at $66,000,000, and of refractory clay at $4,250,000; china clay at 27,000 short tons. The last showed a slight falling off; the others increased.

Coal.—The output of coal amounted in 1897 to 194,483,006 tons, of which 49,537,675 tons were anthracite and 145,000,000 tons bituminous coal. The aggregate value was $205,500,000 bituminous coal, at an average value of only 90 cents per ton, amounting to $130,050,000. The anthracite output declined, owing to the large stocks on hand at the beginning of the year. Bituminous coal increased in quantity, and was, on the whole, cheaper than ever before, though better prices were obtained in some districts toward the end of the year.

The United States is still behind Great Britain as a coal producer, but is approaching, and in a few years, possibly even in 1898, will exceed the enormous output of that country. As practically all our output is consumed in the country, the United States is much the largest consumer of coal. The cost of producing and average selling price of coal is lower here than in any European country.

Coke.—The quantity produced increased with the increased make of iron, and amounted to 11,774,000 short tons, valued at $21,446,000. This is one of the few articles of which the market price was notably higher than in 1896, owing to the action of the Frick Company, the largest producer of the article.

Cobalt oxide is produced in small quantities from material mined as lead ore in Missouri.

Copperas.—This is produced from scale and other

MINERAL PRODUCTION OF THE UNITED STATES IN 1896–7.

(PRELIMINARY STATEMENT.)

Compiled for THE MINERAL INDUSTRY, Vol. VI.,

By Richard P. Rothwell, editor of the *Engineering and Mining Journal*.

Number.	Products.	Customary Measures.	1896. Quantity. Customary Measures.	1896. Quantity. Metric Tons.	1896. Value at Place of Production. Totals.	1896. Value at Place of Production. Per M. Ton.	1897. Quantity. Customary Measures.	1897. Quantity. Metric Tons.	1897. Value at Place of Production. Totals.	1897. Value at Place of Production. Per M. Ton.
	NON-METALLIC.									
	Abrasives:									
1	Carborundum	Sh. T.	595	530	$365,612	*$0.68	621	563	$153,812	*$0.27
2	Corundum	Sh. T.	250	227	35,000	154.18	220	208	32,069	154.18
3	Crushed steel	Lbs.	692,800	296	50,624	171.00	647,800	294	51,824	176.00
4	Emery	Sh. T.	1,550	1,406	108,500	77.17	1,500	1,361	105,000	77.21
5	Garnet	Sh. T.	2,842	2,578	96,628	37.48	4,000	3,629	160,000	44.08
6	[illegible]stones	Sh. T.	31,301	28,395	294,338	10.36	37,200	33,748	372,000	11.02
	[illegible]nes				14,852				12,000	
	[illegible] & inf. earth	Sh. T.	2,425	2,199	31,028	14.11	2,862	2,596	36,629	14.11
9	Whetstones				105,301				80,200	
10	Alum	Sh. T.								
	Asbestos and talc:									
11	Asbestos	Sh. T.	716	650	12,670	19.49	770	698	15,400	[22.06
12	Soapstone	Sh. T.	24,319	22,062	265,806	12.05	7,200	6,532	72,000	11.02
13	Talc, common	Sh. T.					9,375	8,505	93,750	11.02
14	Talc, fibrous	Sh. T.	45,000	40,824	315,000	7.71	32,420	29,411	226,940	7.72
15	Asphalt	Sh. T.	20,500	18,597	66,900	3.59	20,800	18,870	67,743	3.59
16	Asphaltic limestone	Sh. T.	3,119	2,829	8,714	3.08	2,380	2,168	6,677	3.08
17	Bitumin's sandstone	Sh. T.	53,119	48,189	138,714	2.88	37,000	33,566	92,500	2.75
18	Barytes	Sh. T.	21,900	19,867	87,600	4.41	27,316	24,781	109,264	4.41
19	Bauxite	L. T.	17,006	17,369	68,384	3.93	18,000	18,288	126,004	6.89
20	Borax	Lbs.	15,258,014	6,921	762,900	*.11	18,000,000	8,165	900,000	*.11
21	Bromine	Lbs.	550,285	249	143,074	*.57	487,149	221	125,953	*.57
22	Calcium carbide	Sh. T.	800	780	48,000	61.54	1,925	1,746	134,750	77.18
23	Cement, nat. hydraul.	Bbls.a	7,454,611	1,014,417	4,353,377	4.29	7,721,215	1,050,696	4,347,925	4.14
24	Cement, Portland	Bbls.b	1,092,654	187,303	1,170,151	9.12	2,100,000	281,021	3,570,000	9.36
25	Clay, refractory	Sh. T.	4,000,000	3,628,775	4,800,000	1.32	4,250,000	3,855,575	5,089,369	1.32
26	Clay, china	Sh. T.	29,418	26,688	217,551	8.15	27,000	24,494	199,626	8.15
27	Clay, common	Sh. T.			*65,000,000				66,000,000	
28	Coal, anthracite	Sh. T.	48,855,563	44,321,476	88,105,837	1.98	49,537,675	44,940,579	86,690,931	1.93
29	Coal, bituminous (h)	Sh. T.	137,516,631	124,735,087	115,009,979	.92	144,901,331	131,454,487	118,699,151	.90
30	Coal, cannel	Sh. T.	54,650	49,587	146,488	2.95	45,000	40,824	121,500	3.00
31	Coke	Sh. T.	10,359,584	9,398,153	17,271,871	1.84	11,774,273	10,681,620	21,446,321	2.00
32	Cobalt oxide	Lbs.	12,825	5,817	16,672	*2.87	19,300	*8,654	32,810	*3.79
33	Copperas	Sh. T.	11,170	10,133	52,662	5.19	11,924	10,917	56,609	5.19
34	Copper sulphate	Lbs.	48,732,840	22,105	1,949,313	88.18	*46,652,000	21,161	1,866,021	88.18
35	Chrome ore	L. T.	702	713	7,775	10.90	50	51	526	10.90
36	Feldspar	L. T.	22,199	22,554	113,829	5.00	22,000	22,352	111,760	5.00
37	Fluorspar	Sh. T.	6,000	5,443	35,978	6.61	9,025	8,187	58,305	7.11
38	Gilsonite (k)	Sh. T.	1,700	1,542	54,500	35.34	1,756	1,592	56,261	35.34
39	Graphite, crystalline	Lbs.	465,006	*183,709	18,225	*.10	1,021,132	*463,185	45,950	*.09
40	Graphite, amorphous	Sh. T.	574	520	3,850	*.40	1,200	1,000	11,400	10.45
41	Gypsum	Sh. T.	231,649	210,150	739,799	3.52	235,000	213,192	673,148	3.11
42	Iron ore	L. T.	14,650,000	14,884,400	28,567,500	1.92	17,846,000	18,131,536	30,338,200	1.67
43	Lime	Bbls.c	60,000,000	5,443,164	30,000,000	5.50	61,000,000	5,533,920	30,500,000	5.50
44	Magnesite	Sh. T.	2,057	1,875	9,715	5.12	1,907	1,730	7,628	4.41
45	Manganese ore	L. T.	162,526	165,126	339,083	2.05	158,477	161,012	337,432	2.03
46	Mica, ground	Sh. T.	429	398	2,195	5.51	3,535	3,207	35,350	11.02
47	Mica, sheet	Lbs.	8,000	*3,629	8,405	*2.31	50,000	45,359	104,779	2.31
48	Mineral wool	Sh. T.	5,953	5,400	61,714	11.43	3,327	3,019	33,270	11.02
49	Monazite	Lbs.	17,500	8	875	109.37				
50	Natural gas				10,000,000				10,000,000	
51	Paints, mineral	Sh. T.	54,153	49,127	973,368	19.81	62,169	56,400	1,040,684	18.45
52	Paints, vermilion	Sh. T.	96	87	94,677	1088.25	96	87	94,677	1088.25
53	Paints, white lead	Sh. T.	95,068	86,246	7,862,267	90.46	96,197	87,270	8,657,730	99.20
54	Paints, zinc oxide	Sh. T.	16,790	15,240	1,259,925	82.67	26,275	23,837	2,102,000	88.64
55	Petroleum (crude)	Bbls.d	61,396,394	8,364,631	56,993,137	6.81	66,000,000	8,991,825	52,734,000	5.98
56	Phosphate rock	L. T.	878,680	892,748	2,643,706	2.95	890,000	913,240	2,694,058	2.95
57	Marls	L. T.	135,000	137,480	418,500	2.65	155,000	157,480	418,500	2.65
58	Precious stones				200,000				62,000	
59	Pumice						1,700	1,542	8,500	5.51
60	Pyrites	L. T.	117,782	119,666	297,853	2.49	128,618	130,676	380,299	2.91
61	Salt, evaporated	Bbls.e	11,156,270	1,416,846	4,828,179	3.41	14,455,788	1,836,883	6,385,750	3.47
62	Salt, rock	Bbls.e	2,198,308	279,184	711,919	2.55				
63	Silica, sand & quartz	L. T.	720,399	731,925	1,076,098	1.47	750,000	762,000	1,104,900	1.45
64	Slate, roofing	Sq'es.	699,100		2,260,862	n3.24	690,000		2,211,502	n3.20
65	Slate, manufactures				467,575				465,000	
66	Soda, natural	Sh. T.	3,000	2,722	65,000	23.88				
67	Soda, manufactured	M. T.		158,975	3,656,425	23.00		177,000	4,071,000	23.00
68	Stone, limestone (flux)	L. T.	4,311,563	4,380,548	1,724,625	.39	4,745,988	4,821,924	1,735,892	.36
69	Stone, marble				2,600,429					
70	Stone, onyx	Cu. ft	3,000		24,000	p8.00			32,000,000	
71	Stone, oölitic	Cu. ft	4,040,999		755,891	p.18				
72	Other building stones				27,219,484					
73	Strontium sulphate	Sh. T.					40	36		
74	Sulphur	L. T.	2,800	2,845	64,200	22.57	1,630	1,717	34,645	20.17
75	Sulphuric acid									
76	Est. prod. unspecified				5,000,000				5,000,000	
	Total non-metals				492,183,849				504,609,934	
	METALS.									
77	Aluminum	Lbs.	1,300,000	*589,676	520,000	*.88	4,000,000	*1,814,400	1,542,240	*.85
78	Antimony	Sh. T.	613	556	63,778	114.70	750	680	78,000	114.70
79	Copper (m)	Lbs.	467,822,973	212,208	49,729,582	234.35	475,338,340	215,618	52,478,252	243.39
80	Gold	Ozs. f	2,558,433	*79,576	52,886,209	*664.60	2,685,000	83,514	55,498,950	664.60
81	Iron, pig	L. T.	8,623,127	8,761,097	91,577,610	10.45	9,491,976	9,643,847	91,122,970	9.45
82	Lead, value at N. Y.	Sh. T.	174,792	158,570	10,381,843	65.47	194,530	176,476	13,931,348	75.95
83	Platinum	Ozs. f	300	*6.21	2,800	450.89	200	*6.21	2,800	450.89
84	Quicksilver	Flks.g	29,863	1,036	1,104,997	1066.60	26,079	905	991,002	10.95
85	Silver, comm'l value	Ozs. f	58,488,810	*1,819,208	39,245,991	*21.57	56,117,000	1,745,563	33,557,966	19.63
86	Zinc	Sh. T.	77,637	70,422	6,074,219	86.24	100,103	90,813	8,247,544	90.85
	Total metals				251,587,024				257,451,172	
	Grand totals				743,770,873				762,061,106	

(a) Barrels of 300 lbs.; (b) 400 lbs.; (c) 200 lbs.; (d) 42 gals.; (e) 280 lbs. (f) Troy ounces. (g) Flasks of 76½ lbs. (h) Bituminous coal includes brown coal and lignite. The anthracite production is the total for Pennsylvania, Arkansas, and Colorado. (i) Estimated. (j) Kilograms or per kilogram. (k) Including bitumen from Texas. (m) The value of the copper production is calculated at 0 25c. per lb. less than the average price of Lake copper at New York. (n) Value per square. (p) Value per cubic foot.

Abbreviations: Sh. T., short tons (2000 lbs.); L. T., long tons (2240 lbs.); M. T., metric tons (2204.6 lbs.); Sq'es, squares (100 sq. ft., lapped and laid).

waste material at a number of our wire mills and rolling mills.

Copper Sulphate.—This product is made at several of our refining works from copper in forms that have not been included in the statistics of copper; it is an important article, amounting in 1897 to 46,652,000 pounds. Much of this bluestone is exported to Europe.

Feldspar.—The production was about the same as in the previous year. This mineral is consumed almost entirely by the potters of Trenton, N. J., and East Liverpool, O.

Fluorspar.—The production increased from 6,000 short tons to 9,025 short tons. There were three producers, all of them operating in the district covering Southern Illinois and the opposite side of the river in Kentucky.

Gilsonite.—The production was 1,756 short tons, which was a trifle more than in the previous year. It was made entirely by two companies in Utah.

Graphite.—There was a considerable increase in the production of both crystalline and amorphous graphite; the output of the former in 1897 amounted to 1,021,132 pounds, which was nearly all mined in New York; while of the latter there was produced 1,200 short tons, which was mined entirely in Rhode Island.

Gypsum.—There was a small increase in the production; in 1897 the output was 235,000 short tons ($673,148), which was quarried chiefly in New York, Michigan, Kansas and Iowa.

Gold.—The production of gold in 1897 was 2,685,000 fine ounces, valued at $55,498,950, against 2,558,433 fine ounces, valued at $52,886,209, in 1896. The production in the Transvaal was about the same as in the United States, and it will be doubtful which country will hold first place until revised figures are obtained. There was a large increase in the gold production of Colorado, which has now surpassed California for the first time, but the increase in that State was offset by decreases in certain others. The gold production of the Klondike, which was only $2,000,000, notwithstanding the exaggerated newspaper reports, has been credited to Canada, and the latter country shows consequently a great increase in output. The most important gold-producing district in the United States was Cripple Creek, which broke its best previous record. Other important districts of the year were the Black Hills, South Dakota; Mercur, Utah; and the various camps of the Mother Lode in California.

Iron Ore and Iron.—The total production of iron ore in the United States in 1897 was 17,846,000 tons, of which 12,550,000 tons were from the Lake Superior region. The consumption was less, the stocks on hand being 800,000 tons greater at the close of the year than at the opening. Imports were 450,000 tons.

The production of pig iron was 9,491,796 tons—a large increase over 1896, and the greatest output ever reported in a single year, exceeding that of 1895 by about 46,000 tons.

Lead.—The production of lead in 1897 was 194,530 short tons, valued at $13,931,348, against 174,792 short tons, valued at $10,381,843, in 1896. Besides this, there was a large amount of lead produced in the United States from foreign ore and bullion, a large part of which was exported after desilverization. The increase, which was proportionately largest in Missouri, is accounted for by the high price of the metal during most of the year. The chief sources of domestic lead supply continue to be the Cœur d'Alene district of Idaho, Leadville, Colorado, and the vicinity of Bonne Terre, Mo. The exportation of foreign lead refined in bond during the first ten months of the year was 41,910 short tons. The exportation of domestic lead during the same period was 5,637 tons.

Lime.—The production is estimated at 61,000,000 barrels ($30,500,000), against 60,000,000 barrels ($30,000,000) in 1896.

Limestone.—The production of limestone for iron flux was 4,745,988 long tons, valued at $1,735,892, against 4,311,563 long tons, valued at $1,724,625, in 1896. The increase was proportionate to the increase in the make of pig iron.

Magnesite.—This mineral is mined only in California, where there are large deposits. The production in 1897 was 1,907 short tons, against 2,057 in the previous year.

Manganese Ore.—The production fell off from 162,526 long tons ($339,083) to 158,477 long tons ($337,432). This includes the high grade manganese ore produced in Virginia, Georgia and Arkansas, together with the manganiferous iron ore of Colorado and Lake Superior and the franklinite residue of the New Jersey zinc works.

Marl.—The production in 1897 was 155,000 long tons, valued at $418,500, estimated the same as in the previous year.

Mica.—The production of sheet mica was 50,000 pounds ($104,779); that of ground mica was 3,535 short tons ($17,675). In each case there was a large increase over 1896. The domestic production of mica is derived from New Hampshire, North Carolina and South Dakota.

Mineral Paints.—There was in 1897 a production of 62,169 ($1,040,684) short tons of ocher and ferric oxide, natural and artificial; 96 short tons of vermilion ($94,677); 96,197 short tons ($8,657,730) of white lead, and 26,275 short tons ($2,102,000) of zinc white. In each case there was a large increase over the previous year, particularly in the case of zinc white.

Mineral Wool.—The production was 3,327 short tons ($33,270) in 1897, against 5,953 ($61,714) in 1896. The falling off was due to decrease in the number of new buildings in which this material is used.

Monazite.—Owing to the competition of the Brazilian mineral there was no production in the United States in 1897.

Natural Gas.—The production is estimated at $10,000,000, the same as in 1896.

Nickel.—The production was 3,932,245 pounds in 1897, against 3,696,939 pounds in 1896. With the exception of a few thousand pounds, this was derived entirely from Canadian matte. The nickel market was quite devoid of interest in 1897.

Phosphate Rock.—There was an increase of about 10,000 long tons in the production, which was due entirely to the mines of Tennessee. Both South Carolina and Florida showed a falling off, the conditions continuing unfavorable to the industry in those States. The total production in 1897 was 890,000 long tons, valued at $2,694,058.

Petroleum.—The production was 66,000,000 barrels, against 61,396,394 barrels in the previous year. There was an increase in the output of the Pennsylvania, New York and West Virginia fields, and a larger one in those of Ohio, the yield of which is now upward of 40 per cent. of the total.

Platinum.—A small amount of this metal is produced in the refining of certain gold which is obtained in California. We estimate the production in 1897 as 200 ounces, the same amount as in the previons year.

Precious Stones.—The production in 1897 was valued at $62,000, against $200,000 in the previous year. The figures for 1896 were probably overestimated.

Pumice.—There was a production of 1,700 short tons, valued at $8,500, which was derived from Utah and Nebraska. This was a new industry in 1897.

Pyrites.—The production in 1897 was 128,618 long tons, valued at $380,299, against 117,782 long tons, valued at $297,853, in 1896. This was produced chiefly by one mine in Massachusetts and two in Virginia. The increase in production was due to the continued high price of brimstone and the consequent change of many acid makers from brimstone to pyrites as a source of sulphur.

Quicksilver.—The production of quicksilver in 1897 was 26,079 flasks, valued at $991,002, against 29,863 flasks, valued at $1,104,997, in 1896. The falling off was due to the unfavorable results of the exploitation of several mines in California, which were formerly important producers. The production in 1897 was still a good deal more than was required for domestic consumption, but there was a decrease in the exports corresponding more or less to the decrease in production.

Salt.—The production of salt in 1897 was 14,455,788 barrels of 280 pounds, valued at $1,836,883, against 13,354,573 barrels, valued at $1,696,030, in 1896. Upward of 90 per cent. of the production in 1897 was evaporated from brine, there having been a large falling off in the production of rock salt in Kansas. Included in these figures is the salt used in the manufacture of soda ash, in which there was an increase.

Silica, Sand and Quartz.—The production of silica, sand and quartz in 1897 was 750,000 long tons, valued at $1,104,900, against 720,399 long tons, valued at $1,076,038, in 1896.

Silver.—The production of silver of domestic origin in the United States in 1897 was 56,117,000 fine ounces, against 58,488,810 fine ounces in 1896. In addition to this, there was a production of 39,325,000 fine ounces from foreign ores and bullion, against 33,133,529 fine ounces in 1896. The decrease in the American production is accounted for by the heavy decline in the value of silver, which compelled a number of important producers to close down. The falling off in production would undoubtedly have been greater had it not been for the high price of lead during a considerable part of the year. A very large proportion—probably 80 per cent.—of the silver production of the United States is now derived from ores in which gold, lead or copper is the more important element of value. In both British Columbia and Mexico there was an increase in the production of silver; in the former it corresponded more or less to the increase in the production of lead and copper; in the latter, where business is conducted on a silver basis, the cost of labor falls proportionately with the value of silver, and silver mining is not affected to the same extent as in countries which are on a solid gold basis. There was a considerable increase in the lead production in Mexico in 1897, and an in-

crease in the silver production was consequently to be expected.

Slate.—The production of roofing slate was 690,000 squares, valued at $2,211,502, against 699,100 squares, valued at $2,260,862, in the previous year. Prices remained the same as in 1896. The export trade, which was developed in the latter year, was retained. The manufactures of slate, other than roofing slate, amounted, in 1897, to $465,000, against $467,575 in the previous year.

Soda.—The production of soda ash, reckoned on a basis of 58 per cent., was 177,000 metric tons, valued at $4,071,000, against 158,975 metric tons, valued at $3,656,425, in 1896. The growth of this industry is highly gratifying in view of its comparatively recent establishment in this country.

Sulphur.—The production in 1897 was 1,600 short tons, valued at $34,645, against 2,800 short tons in 1896, valued at $64,200. Of the production in 1897, 1,000 tons were from Utah and the remainder from Louisiana.

Stone.—The production of stone of all kinds, for building and road material, in 1897, was $32,000,000, against $30,599,804 in 1896. The increase is attributable to the general improvement in industrial conditions.

Zinc.—The production of zinc in 1897 was 100,103 short tons, valued at $8,095,717, against 77,637 short tons, valued at $6,074,219, in 1896. This increase, which was made entirely by the Western producers, was due to the higher price for spelter which ruled throughout the year. The exportation of zinc from the United States was very large, amounting to 12,455 short tons during the first ten months of the year. The increase in the domestic consumption of spelter was not so large as the increase in production.

BRITISH FRESH WATER MITES.

I HAVE again the pleasure of increasing my list of Arrenuri by the addition of four more species, three of which I have taken in my own immediate neighborhood; the other one was found by Mr. Soar at Sunningdale.

Fig. 1.—Arrenurus buccinator (male). This very beautiful little mite is well figured, though rather highly colored, by Koch, in his "Deutschlands Crustaceen," Heft 13, Fig. 7, mas. He says it is Muellers buccinator. Koch figures a mite, which he considers to be De Geer's caudatus, which, however, is different apparently from my mite, not having the peculiar last joint, but two of the hind legs, and being destitute of the very remarkable hairs on the tail, to be found in tailed mites generally. These, however, may have been accidentally rubbed off in the specimen from which Koch made his drawing. Doubtless, when Piersig's great work on "Water Mites," now in progress, reaches Arrenurus, all these difficulties will disappear; I fear, however, that it will be some time before that portion is published. The female, Fig. 2, dorsal surface, and Fig. 3, ventral surface, is in shape very much like many other female Arrenuri. Its identity is, however, very well made out, because it has been taken by myself, coupled with the male, on more than one occasion. The process is well described by Mueller; it is very curious, and, as in the fleas, the female is uppermost, and is larger and more powerful than the male. Mr. Soar gives the length of the male in this species as 1·63 mm., and that of the female 10·86 mm.

Fig. 4.—The next mite is Arrenurus zachariae. I have not seen this mite alive, but have had the pleasure of examining it in preservative solution, which, however, unfortunately, discharges the colors. It was found by Mr. Soar at Sunningdale. The formation of the tail, as will be seen by the figure, is very different from the other tailed mites. It was named by Koenike, and is probably rather rare in England, one specimen only having been found. Its legs are much like those of A. buccinator and many other tailed mites. Mr. Soar gives its length as 1·04 mm.

Fig. 5 has been named Arrenurus festivus by Koenike. The tail will be seen to be more cylindrical, the sides straighter, and the termination more dilated than is found in the other mites here figured. Mr. Soar gives its length as 1·32 mm. I found it in company with A. buccinator. I have not detected the female belonging to this mite. Fig. 6 represents a male Arrenurus, with a much shorter and broader tail than the others; I have not been able to make out its name. It was found by Mr. Soar, at Staines, last year, and I myself met with it on several occasions, so that it is by no means rare, and therefore has doubtless been described and named. It resembles somewhat Arrenurus albator, Mueller, but has the central part, or petiole, of the tail spear-shaped. In Zoologischer Anzeiger, No. 401, for September, 1892, p. 342, is a figure of a tail of a mite something like this, with the exception of the petiole, which is there heart-shaped. I shall be very glad, if any reader of Science Gossip has met with a description or figure of this mite, if he will kindly give me the reference to it. Fig. 7 represents the ventral surface of this doubtful Arrenurus.—C. F. George, M.R.C.S., in Science Gossip.

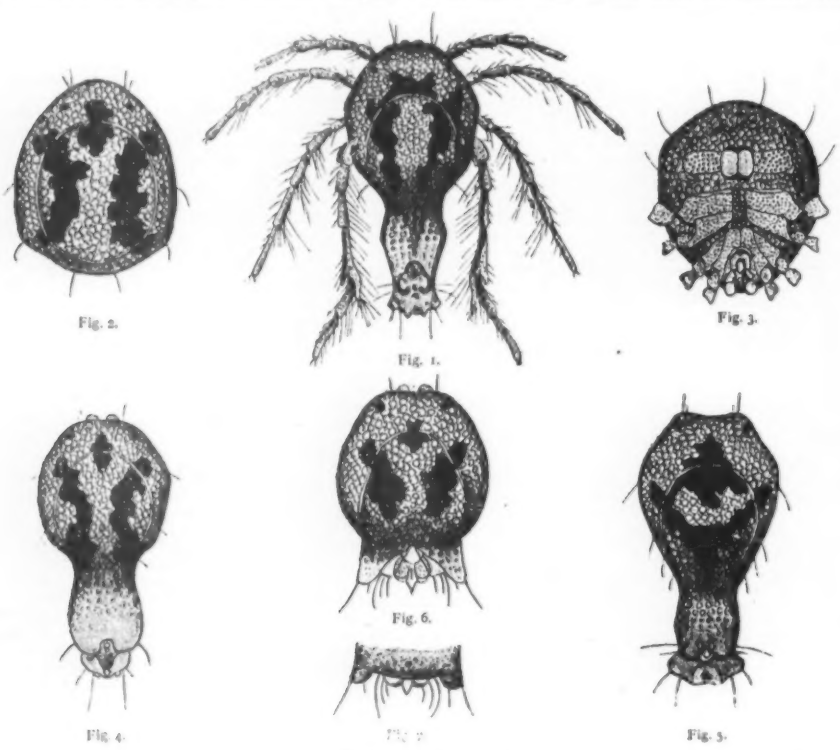


Fig. 2. Fig. 1. Fig. 3.

Fig. 4. Fig. 6. Fig. 5.

WATER MITES.

Fig. 1, Arrenurus buccinator; Fig. 2, dorsal surface, A. buccinator, female; Fig. 3, ventral surface, A. buccinator, female; Fig. 4, A. zachariae; Fig. 5, A. festivus; Figs. 6 and 7, Arrenurus (? sp.) and its ventral surface.

THE DAYS OF REST OF PREHISTORIC MAN.

ON the three ill-omened days of rest of prehistoric man which were connected with the dead and "stained with the shadow of death," no work could be done and prosper. They were intensifications of the sailor's Friday. Why those monthly sabbaths were connected nearly all the world over with the number three, it is difficult to conjecture. The Peruvians, and probably other races, believed that the moon every month died for three days and rose again; but if this suggested the number three we should expect the days of the dead to occur then, whereas they were generally held at the beginning instead of at the end of "the dark half of the moon," and hence the seventeenth, eighteenth and nineteenth days of the moon were nearly everywhere regarded as unlucky. How singularly the number three is connected with mourning and "days of the dead" will be apparent from the following paragraphs, to the language of which I specialy invite attention: "Have they any belief in the immortality of the soul? To this I cannot reply with certainty. But what is the meaning of the tears and lamentations of the poor mother, who for three days and three nights lies stretched on the grave of her little son, calling him by his name, and repeating in broken sobs, 'Oh, come back, beloved one; come back to thy mother!' 'It is not for thee to hear her greetings until she has freed herself from her consecration to the gods below, and the third day arrives.'" This reads as if it were continuous and referred to some one person. Yet the interval in time and space indicated by the first part and the last suggests an abyss of time of perhaps scores of thousands of years, and a distance in space equal to that of half the circuit of the globe. The first part is a quotation from D'Albertis' description in his "New Guinea" (vol. i, p. 143) of a Papuan mother mourning for her son, while the second part is a quotation from the Alcestis of Euripides (line 1138, Trans. Simpkin & Marshall, 1881).

The author of "Five Years in the West Indies" gives a curious negro superstition about the three days of the dead. "'We go dead one day; next day we shiver in de coffin, and de next day we go dead again till all things come quite down.' I need hardly say I endeavored to remove this belief, but I found it to be an almost universal opinion among the negroes." Among that primitive race, the Nagas of India, we meet with these three days of the dead. Godden, in his "Naga and Other Frontier Tribes" (Journ. Anthrop. Inst., No. 90, 1896, p. 190), says: "The old accounts of funeral rites evidently refer to a 'death genna,' where it is stated that after the death of a man of any standing, none of the inhabitants of a village quitted it for three days; and that for three or four days after a death the relatives do not leave the village, neither do the other villagers resort to a village in which a death has occurred during that period" (ibid., 171). In the valuable report on the aborigines by a committee of the Legislative Council of Victoria (Session 1858-59) we find that Mr. Hull states respecting the natives: "Their grand corroborees are held only in the spring when the Pleiades are most distinct, and are a worship of the Pleiades as a constellation which announces spring. Their monthly corroboree is in honor of the moon" (p. 9). C. J. Tyres also says: "They sing and dance to gain the favor of the Pleiades (Mormodellick), the constellation worshiped by one body as the giver of rain." I need hardly add that the southern spring is about November. In my "Festival of the Dead," I state: "We are told that 'all the corroborees of the natives are connected with a worship of the dead, and last three days.' In confirmation of this a member of the Nova Scotian Institute of Natural Science, who has been at these annual corroborees, tells me that, as the natives for these occasions paint a white stripe on their arms, legs and ribs, they appear, as they dance by their fires at night, like so many skeletons rejoicing." We are told by another person who was examined by the committee that at all the corroborees the natives "make offerings to the dead, when after three days of continued dancing their bodies are cleared from all appearance of mourning, and there is rejoicing in its stead."

Substantially the same calendar is found among the Polynesians, who divide their year into two seasons. The one is "the Pleiades above," and the other, "the Pleiades below." But the Australian mode of watching the time when the Pleiades are to be seen all night long is a little more accurate than the division of the year by the Polynesians into the two seasons of the Pleiades, and is a perfect calendar for primitive races, which regulates time by the aid of moons, instead of months, the beginning of the year being at the full moon, which is nearest to the time when the Pleiades are overhead at midnight, i. e., November. Where we find clear traces of early Negrito or Nigrillo influences, there we meet with distinct vestiges of the year of the Pleiades, and of three "Days of the Dead." As there are comparatively few indications of a primitive dwarf population having existed north of the Rio Grande, we hear but little among northern tribes of the Pleiades and of days of the dead. One Indian tribe in British Columbia for three days commemorates the dead in November. Among the Polynesians and the Papuans nearly all festivals are of three nights' duration, and funereal. Ellis tells us that the Society Islanders regard the seventeenth, eighteenth and nineteenth nights of the moon as seasons 'when spirits wander more than at any other time." Nearly everywhere we find traces of these ideas, but especially as respects the seventeenth day of the moon. Bishop Chalmers says of the Dyaks of Borneo: "During the farming season, the day after the full moon and the third day after it are 'Pamali' and no farm work can be done."

In India these three unlucky days of the moon can be traced, and are called Dagda (stained or burned by death). Dubois speaks of a festival "called by the Hindoos 'Mahanavami,' which is devoted principally to the honor of deceased ancestors. It is celebrated in the month of October, during a period of three days, and is so religiously kept that it has become a proverbial saying that those who have not the means of celebrating it should sell one of their children to procure them." Sir William Jones says that the Hindoos in every lunar month, on Mahacala, make "offerings to the manes of the Pitris, or certain progenitors of the human race, to whom the darker fortnight is peculiarly sacred" (vol. iv, p. 129). He also says, referring to a Hindoo work, "Many subtle points are discussed by my author concerning the junction of two, or even three, lunar days in forming one fast or festival." The three days of the dead, the "Dewali" (the spirits), are observed in Northern and Western India almost simultaneously with those fossil survivals in our calendar, October 31, November 1 and 2—All Hallowe'en, All Saints, and All Souls. The English peasant still goes "a-souling" on All Souls' Day, praying from house to house for "a soul cake for all Christian souls," while the Hindoo is offering his funeral cake to the manes of deceased ancestors. A Hindoo often adopts a boy as a son when he is childless, so that he may have some one surviving him who will annually offer him a funeral cake when he is no more. Even when primitive races tried to advance a step beyond their rude star lore into astronomy, and divided the year into 360 days, and the month into thirty days, inventing a week of five days, six of which made a month, and seventy-two a year, they still retained the three days' corroboree at the end of the year, though in a fossil state. It was necessary to add five days in order to make up the 365 days; but these were not included in the days of the year, but constituted a month of five days, which, however, was not counted. They were ill-omened, and the third day was specially connected with the dead, as well as the two days following it.

Don Juan Pio Perez, of Yucatan, speaking of the Yucatan calendar, says: "Five supplementary days were added at the end of each year, which made part of no month, and which, therefore, they called 'days without a name.' They called them also 'Yuab,' or 'Yuab Jaab.' The word Yuab may be derived from Yua, which means to be destroyed, wounded, corroded by the caustic juice of plants, or with ley, or other strong liquids [i. e., 'stained with death']. On this account," he adds, "the Indians feared those days, believing them to be unfortunate, and to carry danger of sudden death, plague, and other misfortunes. For this reason these five days were assigned for the festival of the god Main (the 'grandfather')." The three days' feast of the dead is indicated by the first of the three last days being called Cemis (spirits of the dead). The name Typhon (the principle of evil) was by the Egyptians applied to this day in their calendar, and it was looked on as an evil day, "for which reason," says Plutarch, "the kings of Egypt would transact no public business on it, nor even attend to the care of their persons on that day."

Before the great festival about November in Samoa, a herald walked through the villages announcing, "Thou shalt not work; thou shalt rest, doing no work!" Everyone not taking part in the procession or sacred rites had to remain within doors, or death was the penalty. Admiral Erskine refers to this sabbath,

which continues throughout the month of November in Fiji. "There is a month in the year, about November, in which the god comes from Bulu, the world of spirits, to make the bread fruit and other fruit trees blossom and yield fruit. He seems to be a god of peace, and cannot endure any noise or disturbance, and his feelings in this respect are most scrupulously regarded by the natives. They therefore live very quietly during this month, it being tapu to go to war, or to sail about, or plant, or build houses, or do most kinds of work, lest Ratumainbulu should be offended and depart again to Bulu, leaving his important work unfinished." ("Islands of the Western Pacific," p. 244.)

The Persians preserved traces of the monthly corroboree, for in each month there were three ill-omened days. The 17th day of the month of Murdad (November in their ancient calendar), on which the angel of agriculture and death (Murdad) came up to earth, was peculiarly unlucky, and no work could be done on it, and rulers could not refuse any favors asked of them then. At that time in Rome, Pluto, the god of agriculture and death, also came up to earth, and that period was "stained with the shadow of death," for no work could be done then, no war declared. The Romans regarded days of the dead as nefasti, and the Greeks looked on them as "stained," or "ill-omened."

That the God of Rain visited the earth in November we have living testimony probably ten times as old as the oldest Babylonian monuments discovered lately at Nippur. Those venerable survivals from a primordial Negrito race, the isolated pygmies of the Andaman Islands in the Bay of Bengal, have a deity like Pluto and the God from Puloto of Western Polynesia, who is called Puluga. Pul, Bul, Bel, Pulo, Pluh, are names signifying "rain," and remind us of the word "pool" in English. Up to the time of the building of the Temple the Hebrews called November the month of Bul (or "rain"). The Deluge is called Mabul ("the great rain"). Dr. Moffatt says that in Bechuanaland the dead send rain, and the only prayer over the dead is the mournful wail, pulo! pulo! (rain! rain!) If the rain does not come, the recently buried corpses are reinterred in a new place, in hopes that it may be acceptable. Pluh is the heaven of the Karens, and both Pluto and Puluga evidently mean "the God of Rain." The latter, who thunders, and sends rain, and judges the spirits of the dead, dwells in a great stone mansion in the sky. He eats and drinks a great deal, for in the rainy season he comes to earth to gather food, being especially fond of certain fruits, and roots and seeds. To touch any of these during the first half of the rainy season (November) would so enrage Puluga that he would again destroy the world by water. This is, no doubt, the earliest history of the sanctity of "first fruits." Those three ill-omened nights (not of the month, but of the moon), the 17th, 18th, and 19th, survive in a fossil form in ancient calendars. The Attic Anthesteria and the Roman Feralia (both funereal in character) were held on February 17, 18, and 19. On the 17th, 18th, and 19th days of Athyr (November) the great feast of Isis took place, a festival of grief, which Plutarch says was held "when the Pleiades were most distinctly visible." He also says that all the great mournful celebrations of the ancients took place at that time (no doubt fossil survivals of the November corroboree of the Pleiades), and that the 17th, 18th, and 19th days of every month were unlucky. But the most striking fossil survival of this primeval feast is found in the Eleusinian mysteries. Ancient Greek authorities assert that "it was the Pleiades who taught the sacred dances and the nightly festival days" (Pannychida, i. e., held all night long). At the Eleusinia, the most venerable of the Greek Mysteries, the three most sacred and mysterious days were the three Pannychida, which were observed all night long, and were connected with the dead.—Canadian Magazine.

CATTLEYA EMPRESS FREDERICK, VAR. LEONATA.

(MOSSIÆ ♀, DOWIANA ♂.)

THE first of this hybrid to flower out of the batch raised by Messrs. Jas. Veitch & Sons was exhibited by Baron Schroder at the Royal Horticultural Society on June 22, 1892, and it was awarded a first class certificate. It had white sepals and petals and a finely colored lip.

The original and its variety are equal in point of beauty, the chief difference being in the variety Leonata having sepals and petals of a bright rose color shading to silvery white at their bases. The broad labellum is of a deep purplish crimson in front, and bears handsome orange colored lines radiating from the base. We are indebted to The Gardeners' Chronicle for the cut and copy.

CATTLEYA EMPRESS FREDERICK, VAR. LEONATA: HORT VEITCH.
(Lip purplish-crimson, with orange veins.)

TEMPERATURE IN DEEP MINES.

MR. JAMES STIRLING, Government Geologist for Victoria, Australia, in a paper published in "The Transactions of the Australasian Institute of Mining Engineers," says:

"The importance of obtaining a record of the temperature of rock masses in deep mines can hardly be over-estimated. It has a direct bearing on future mining operations in Australasia. The facilities existing for such observations in the deep mines at Bendigo induced the writer to recommend that a series of observations be made, not only of rock temperature, but of the composition, etc., of the air in relation to the subject of ventilation. It had long occurred to him that the accepted formula used by physicists for determining the rate of increase of heat with the depth was not an absolute one, and might be modified in the light of recent deep mining in various parts of the world. In order to obtain some data which might be presented to mining engineers for their consideration, he undertook to make some systematic observations. For this purpose several of the deepest mines at Bendigo were selected, and holes were driven into the rock consisting of Silurian slates, sandstones, quartz veins and a Tertiary dike (Limburgite). Thermometers were placed in the bore holes, plugged up with cotton wool and clay to exclude the external air. The following instruments were used: Maximum and minimum thermometers, wet and dry bulb thermometers, aneroid barometers and velocity anemometers."

Mr. Stirling deduced his conclusions of deep temperatures at Bendigo from carefully plotted curves of temperatures, which were only carried up to the 500-foot level, so as to prevent the influence of variations at and near the surface for different days and on the same day. The ingoing air current showed considerable variation in the curves, but as the depth increased the increase of temperature became gradual, owing to the lessening influence of the cooler inflowing air.

There is not only considerable irregularity in the rate of increase in different parts of the drives, crosscuts, winzes, etc., but also a greater increase (with the depth) of the temperature of the air than that of the rock masses. The rate of increase of temperature of the air with the depth as determined from several of the deep mines at Bendigo is as follows:

TEMPERATURE OF AIR.

Mine.	Depth in Feet.	Rate of Increase.
180	Down to 454	1° F. for every 121 feet.
"	Between 1,294 and 1,750	" " 114 "
"	" 1,750 and 2,701	" " 67 "
"	" 2,701 and 2,295	" " 70 "
"	" 2,295 and 3,110	" " 68 "
"	Surface down to 3,110	" " 171 "
Shenandoah	" " 2,880	" " 115 "
Victoria Quartz	" " 2,810	" " 300 "
Shamrock	" " 2,700	" " 82 "
Great Extl. Hustlers	" " 2,300	" " 74 "
Princess Dagmar	" " 5,226	" " 54 "
United Hustlers and Redan	" " 1,450	" " 32 "

The rate of increase in the United Hustlers may be due to the imperfect ventilation.

Recent investigations of temperatures at great depths in various parts of the world may be quoted as under:

	Depth in Feet.	Temperature.
Schladebach	5,628	133·9° F.
Wheeling, W. Va	4,462	111 "
North Tamarack	4,450	84 "
Calumet and Hecla	4,580	79 "
Bendigo	3,250	97 "

With respect to Lansell's 180 mine and the rate of increase in rock temperature, it is remarked: "Taking the mean temperature (annual) of the surface at Bendigo as 67·9, which is the result of thirty-two (32) years observations, and assuming that the rock temperature below the line or zone of constant temperature (approximately 100 feet from the surface) is the same throughout the year, the following results are obtained:

Depth in Feet.	Rate of Increase.
Down to 454	1° F. for every 110 feet in depth.
" 1,294	1 " " 182 " "
" 1,750	1 " " 173 " "
" 2,295	1 " " 152 " "
" 2,701	1 " " 137 " "
" 3,110	1 " " 110 " "
" 3,250	1 " " 111·5 " "

"If it is assumed that the mean result of all these ratios is the average rate of increase of temperature with the depth, then we have the ratio of 1° F. for every 137 feet in depth, as the record in the Silurian rocks at Bendigo.

COMPARISONS WITH OBSERVATIONS IN OTHER COUNTRIES.

		Depth.
Calumet and Hecla Lode, Lake Superior, U. S. A.	1° for every 223·7 feet.	4,712
Lansell's 180 Mine, Bendigo	1 " 137 "	3,250
Dunkenfield Colliery, England	1 " 83·2 "	2,055
Royal Victoria Bore-hole, Transvaal	1 " 82 "	2,500
St. Gothard Tunnel	1 " 60 "	
Port Jackson Bore-hole, New South Wales	1 " 80 "	2,929
Meudart (near Luxemburg)	1 " 57 "	2,400
Wheeling Oil Well in West Virginia	1 " 71·8 "	
Cornwall, England	1 " 56·5 "	2,162
Schladebach Bore-hole, Prussia	1 " 65 "	5,734
Geneva, Switzerland	1 " 55 "	
Paruschowitz Bore-hole, Upper Silesia	1 " 62·1 "	6,573
Westphalia	1 " 54 "	2,124

Touching the fault line temperature, Mr. Stirling says: "In order to ascertain if any difference existed between the temperature of the rock near the fault lines, records were taken at the 2,700-foot level, showing a difference of 2° F. increase over the adjacent strata, thus suggesting that along lines of fault or strain the temperature of the rock is increased. There can be no doubt of the effect which meteoric waters have when circulating along lines of disturbance, or percolating along planes of softer or more porous strata in increasing the temperature by the chemical action of decomposition of sulphurets or other mineral substances.

"While on different dates there were different temperatures of air recorded at the same levels, this was accounted for by the distribution of the air through the drives being affected by the inflow from adjacent mines and by circulation of water in places, and by the difference of conductivity of the rocks, although the differences recorded in the temperatures of the slates, sandstones, quartz and dike (Limburgite) were hardly appreciable.

"Experiments made at the other places show that there is a variation in the increment of heat, due to the varying conductivity of heat at or near the surface; the resistance of opaque white quartz being expressed at 114; basalt at 273. A greater resistance is offered to the transmission of heat in a direction across than in that parallel to their planes of bedding. It has also been observed that in areas where the older formations occur, which are not subjected to the action of eruptive rocks, the rate of increase of temperature with the depth is less than in those areas where volcanic or igneous rocks prevail. So far as these observations have extended at Bendigo, the rate of increase of temperature of the air is greater than the nominal rate of increase of the rock masses."

In regard to the fact determined by Mr. Stirling that the rate of increase of the temperature of air in the deep levels of Bendigo was greater than the normal rate of increase of the rock formations, we suggest as the cause the compression of the air at those levels by the increasing weight of the air columns. Such compression is natural, and in a measure will increase the sensible heat just as compressing air in an air compressor, or in an ordinary air pump, does.

ENGINEERING NOTES.

Superior is to have the largest ore dock on Lake Superior. The contract will be let at once for another extension of the Allouez dock, which will enlarge the present quarters by a sufficient amount to make the entire capacity nearly 60,000 tons. The largest dock at present is the West Duluth No. 1, which can carry 57,600 tons. Ashland and Marquette follow next in size with 36,036 tons and 36,000 tons respectively. There is a strong feeling extant among men engaged in the Duluth-Superior trade that the Wisconsin port is destined to eclipse the glory of its sister port, and this the largest ore dock on Lake Superior, they say, is but one of the later indications of its future supremacy in so far as shipping and commercial greatness is concerned. —Marine Record.

Tests of 5,427 gas meters at Syracuse, N. Y., showed that 1,744 ran from 1 to 18 per cent. fast; 3,035 from 1 to 32 per cent. slow; 616 were classed as correct, showing less than 1 per cent. variation; 616 failed to register; and one would not pass gas. Most of the meters running either fast or slow showed variations of 5 per cent. or less, and only 31 meters out of 1,744 ran more than 7 per cent. fast. The average excess registration for all the fast meters was 2¼ per cent., and for the slow, 3¾ per cent. The tests were made by Mr. T. Littlehales, of Syracuse, N. Y., who states that in all his previous experience he had scarcely ever found a meter running over 8 per cent. fast. The poor registration at Syracuse he attributes largely to the use of old meters of a defective type. We are indebted to The American Gas Light Journal for the above.

The corrosive power of pure water on new or unscaled boilers was well illustrated in the city of Glasgow, when a new water supply was introduced from Loch Katrine, one of the purest waters in the world which are available for city consumption. The former supply had been poor and calcareous and old boilers were much coated with lime scale. To the dismay of the users, those who had put in new boilers or new tubes found them rapidly corroding, while the old scaled and coated boilers remained as before; those, too, who had removed every possible trace of old incrustation from their old boilers by mechanical or chemical means, intending thus to get, as they expected, the full benefit of pure water, were also badly troubled by corrosion, and even the old boilers, as the scale was gradually removed by the unvaryingly soft and pure water from the lake, were more or less corroded when no means were taken to prevent it.

From an article published in Annalen für Gewerbe und Bauwesen it appears, as the result of experiments made by M. Ravel, that 6·35 cubic feet of acetylene gas generate one horse power per hour, which is equivalent to a reduction of two-thirds as compared with petroleum. As to the explosiveness of mixtures of air and acetylene, it was found that 1·35 parts of this gas mixed with one part of air began to be explosive, the explosive force of such mixture rising rapidly as the dilution with air increases, attaining finally a maximum when there are twelve volumes of air with one volume of acetylene; then, as the proportion of air is increased beyond this limit, the explosive force subsides, until at twenty to one it becomes entirely extinct. The flashing point approximates 900° F., whereas in the case of most other gases used to generate power the requisite ignition temperature is about 1,100° F. The temperature of combustion is very much higher than that of the other gases with which it can be compared. The special characteristics of this gas, therefore, as shown by M. Ravel are great rapidity of the transmission of flame, low ignition temperature, high combustion temperature and extraordinary energy evolved in the explosion.

In a valuable contribution to The Digest of Physical Tests and Laboratory Appliances, J. S. Dobie gives the results of experiments made by him as to the action of heat on Portland cement. Over 300 briquettes were prepared for this purpose, some consisting of neat cement, others of one part cement mixed with one, two or three parts of sand, the age of the pieces ranging from two months to four years. The briquettes were heated in a gas furnace to a temperature of from 650° to 1,775° F. After removal from the furnace every briquette was found to have lost weight, while in the neat specimens cracks were usually observed, these latter being less apparent in the others containing sand. After cooling the briquettes were tested for tensile strength, with a load applied at the rate of 400 pounds per minute, and a marked decrease in tensile strength was noted, seemingly connected closely with the loss in weight of the sample. In other cases, in which the reduction in weight showed that practically the whole of the water of crystallization had been driven off, the specimens had practically no breaking strength. The effect of different temperatures was, however, peculiar, since briquettes heated rapidly to 1,775° showed a loss of strength out of proportion to their loss in weight, but, when the heating was slow, these two losses were closely proportioned.

The bulletin of the Anthracite Coal Operators' Association for November quotes from The Black Diamond, a coal trade journal published in Chicago, the following table of weights of various coals:

	Weight per cubic foot. Pounds.	Cubic feet per ton 2,000 pounds.
Lehigh lump	55·26	36·19
Lehigh cupola	55·52	36·02
Lehigh broken	56·85	35·18
Lehigh egg	57·74	34·63
Lehigh stove	58·15	34·39
Lehigh nut	58·26	34·32
Lehigh pea	33·18	37·60
Lehigh buckwheat	54·04	37·01
Lehigh dust	57·25	34·93
Free burning egg	56·07	35·67
Free burning stove	56·33	35·50
Free burning nut	56·88	35·16
Pittsburg	46·18	43·03
Illinois	47·22	42·35
Connellsville coke	26·30	76·04
Hocking	49·30	40·56
Indiana block	43·85	45·61
Erie	48·07	41·61
Ohio cannel	49·18	40·66

MISCELLANEOUS NOTES.

Dum-dum bullets work both ways on the Indian frontiers, as the Afridi tribesmen are blunting the bullet tips, too. The two pipers of the Gordon Highlanders who distinguished themselves at Dargai, lost, one his leg, the other his foot, owing to the terrible splintering of the bone, caused by the "modified" Lee-Metford missiles.

While a circus was parading on Tottenham Road, in the outskirts of London, a baker gave one of the elephants a couple of loaves of stale bread. A few nights after the elephant broke from its fastenings in the town where the circus then was, got away from its keepers and made its way back to the baker's shop, where it broke in the plate glass windows and ate up the bread exposed for sale. It then allowed itself to be led quietly back to its stable.

The wine harvest in France for 1897 has produced 32,351,000 casks of about 25½ gallons each, which is less by 12,305,000 casks than that of 1896. The departments in the south of France have gone beyond their average production, especially Aude, Bouches-du-Rhone, Gard, Hérault, Pyrénées-Orientales, and Vaucluse. But the large product in the region of the Midi has been offset by a poor harvest in the central departments, where a late spring did infinite damage to the vines.

There is a moral in the following anecdote related by Tit-Bits which we commend to the attention of enterprising band masters, organ grinders and builders who are behind time on their contracts. This story is told of an eccentric Hastings parson: One day, on visiting the belfry, he found a whitewasher whistling a dance tune as he worked. The parson reproved him sharply for choosing such music for such a place. "Beg your pardon, sir," said the man, "but I forgot where I was;" and then, to show he was sorry, he started whistling the "Old Hundred." His hand, however, kept time with the music, and so the "Old Hundred" made the whitewash brush go wonderfully slow. "Oh, get back to your dance tune," the old parson shouted, "or the job'll never be done!"

The German government now furnishes its soldiers with one meal a day. If they desire or need more, they have to get it at their own expense. The press has started on a campaign to better this state of affairs, but thus far has met with no success. Among all other nations soldiers' food is distributed in a less niggardly manner. In the French army there are two meals a day, while Russia gives her soldiers three. In certain Russian regiments, even, there are annual cooking contests held under the auspices of a special commission. This contest was instituted by Prince Alexander Petrovitch von Oldenburg when in command of the Guard. The members of the commission pass before the fires, taste the food in all the kettles and write down the numbers designating those that please them. The first prize is a silver watch and chain. The other prizes are also silver watches, but with chains of white metal.

Ornamental designs on the surfaces of waterproof fabrics are now produced, with fine effect, by English manufacturers, the process being a peculiar one. A layer of the usual rubber mixture is spread on the fabric to be waterproofed, this proofing substance being compounded with finely comminuted asbestos, either before the operation of proofing or by spreading the asbestos powder on the prepared cloth. The particular method of applying the asbestos is determined, in each case, by the character of the ornamental effect to be produced; for most purposes a proportion of equal weights of the comminuted and rubber mixture, per square yard of fabric, yielding the desired results, both in respect to quality and appearance. In those cases where the asbestos is applied to the rubber mixture, after being spread, an even layer of farina or other similar material is applied; and the printing operation is then performed by means of rollers, blocks, stencils, stamps, etc.

In North Mexico there is a cotton farm having an area of 175 square miles, and situated 400 feet above sea level. Its site was once the bed of a lake, and in 1889 it was a vast sun-beaten desert supporting nothing but scraggy bushes, which sheltered the prairie dog and the rattlesnake. In that year a Spanish capitalist, aided by the federal government, started converting this arid waste into a thriving cotton farm. A dam was built across the river Navar, and the water was conducted to the estate through 39 miles of canal. The land is divided up into blocks of 4,500 acres, and these blocks are irrigated by means of water channels having a total length of 546 miles. There is a central depot where extensive buildings have been erected for dealing with the produce of the land and for soap manufacture. The whole of the depot is lighted by electricity. The estate is overrun by a steam tramway of two feet gage. The mills are driven by engines of over 300 horse power combined.

The following is a curious and interesting list of the tools and instruments considered necessary for gardening, by the author of "The Florists' Vade Mecum," a little work which reached its third edition in 1702: A Skreen for Fining. A Wier Riddle for sifting Earth. Spades two, a bigger and a less. Shovels two, a bigger and a less. Howes of several sizes. Pruning Hook and Knife. Grafting Knives, Saw, Chissel and Mallet. Pen knife, scizers. Line and Rule. Trowels, broad, narrow, and hollow. Garden Sheers, a Hammer. Iron Rakes, two, a bigger and a longer in the head, a shorter with Teeth thicker set. A Rake with a broad Head, without Teeth for smoothing the Earth in a Bed. Several twig Baskets or Whiskets, and Birch Besomes. Watering Pots, one with a head full of small Holes; another only with a pipe; another with a small Neck, the bottom full of Holes. The first is to water Plants in Summer. The second to water Pots with rank Water wherein the dung of Sheep, Poultry, etc., hath been steeped, that it may be put to the Roots without staining the Leaves. The third being put into Water, will fill from the bottom, which will stay in so long as you stop out the Air with your Thumb at the top; this serves to water young and tender seedlings of Auricula Gilliflowers, and such like, without washing the Earth from them, for by the Motion of your thumb, you may cause the water to fall gently upon them, more or less as you shall desire.—Gardeners' Magazine.

SELECTED FORMULÆ.

Glass Etching Solution.—The fluid commonly used for etching glass tumblers is made as follows:

Sodium fluoride	1 ounce.
Glacial acetic acid	10 drachms.
Water	25 ounces.

Dissolve the sodium fluoride in water, and add the acetic acid.

The article to be etched is first coated with etching varnish, which is scratched off where a pattern is desired, and then immersed in the solution. The fluid is sometimes applied by means of a rubber stamp.

Another formula is the following:

Mix equal parts of ammonium fluoride and barium sulphate, and mix to a soft paste with hydrofluoric acid immediately before using.—American Druggist.

Fruit Essence Formulas.—The following are formulas original in The American Druggist, having been contributed to its pages a little over two years ago by Frank Edel, of Des Moines, Iowa. He recommends the use of linalyl formate, a liquid which has an aroma resembling the oils of petit grain and bergamot. We give the formulas below:

EXTRACT APRICOT.

Linalyl formate	90 mm.
Glycerin	1 ounce.
Amyl valerianate	4 dm.
Alcohol	11 ounces.
Fld. extract orris	1 "
Water, q. s. ad	1 pint.

EXTRACT APPLE.

Glycerin	1 ounce.
Amyl valerianate	4 dm.
Linalyl formate	45 mm.
Fld. ext. orris	1 ounce.
Alcohol	11 "
Water, q. s. ad	1 pint.

QUINCE EXTRACT.

Fld. ext. orris	2 ounces.
Oenanthic ether	1½ "
Linalyl formate	90 mm.
Glycerin	3 ounces.
Alcohol	70 per cent. to 3 pints.

PEACH EXTRACT.

Linalyl formate	120 mm.
Amyl valerianate	8 dm.
Fld. ext. orris	2 ounces.
Oenanthic ether	2 dm.
Oil rue (pure German)	30 mm.
Chloroform	2 dm.
Glycerin	2 ounces.
Alcohol	70 per cent. to 3 pints.

Liquid Glove Cleaner.—

Ether	1 part.
Benzol	2 "

Put the gloves on the hands and rub thoroughly with the solution with a clean piece of flannel. Let the greater part of the fluid evaporate, then remove the gloves from the hands, and hang them in a current of warm dry air until the smell of the liquid is dissipated.

To Render Ground Glass Transparent.—Take hold of the glass by one corner with an ordinary pair of fire tongs. Hold it in front of a clear fire, and heat to about 98° F., or just hot enough to be held comfortably in the hand. Then hold the glass horizontally, ground side uppermost, and pour in the center a little photographer's dry plate negative varnish. Tilt the glass so that the varnish spreads over it evenly, then drain back the surplus varnish into the bottle from one corner of the glass. Hold the glass in front of the fire again for a few minutes, and the varnish will crystallize on its surface, making it quite transparent. The glass should not be made too hot before the varnish is put on, or the varnish will not run evenly. This method answers very well for self-made magic lantern slides. Ground glass may be made temporarily transparent by wiping with a sponge dipped in paraffin or glycerin.—Pottery Gazette.

To Transfer Prints to Paper.—(1) Three drachms common yellow soap, dissolved in one quart of hot water; when nearly cool, add 1¼ ounce fluid spirits of turpentine. Shake well together. Sponge the print with the above solution. Let it soak for a few minutes, and lay on it a piece of damp, white paper. Press together, and on separating you will have a reverse copy of the print on the paper. The cost is little over 1d. (2) Place the engraving a few seconds over the vapor of iodine. Dip a slip of white paper in a weak solution of starch, and when dry, in a weak solution of oil of vitriol. When again dry, lay slip upon the engraving, and place both for a few minutes under a press. The engraving will be reproduced in all its delicacy and finish.

Paste for Tissue Paper.—

(a.) Pulverized gum arabic	2 ounces.
White sugar	4 drachms.
Boiling water	3 fl. ounces.
(b.) Common laundry starch	1¼ ounces.
Cold water	3 fl. ounces.
Make into a batter and pour into Boiling water	32 "

Mix a with b, and keep in a wide-mouthed bottle.

Perfect Paste.—

FOR PAPER ONLY.

(a.) Powdered gum tragacanth	1 ounce.
Boiling water	8 fl. ounces.
(b.) Pulverized gum Arabic	1 ounce.
Salicylic acid	1 drachm.
Boiling water	2 fl. ounces.
(c.) Wheat flour	2 ounces.
White dextrin	4 drachms.
Cold water	2 fl. ounces.
Make into a batter and pour into Boiling water	12 fl. ounces.

Mix a with b, and then add c; finally add 4 drachms of glycerin, to which has been added 8 drops of oil of lavender.

This is a good preparation, but is rather complicated and requires too much work to make up.—Bulletin of Pharmacy.

A UNIQUE CASE OF COMPLETE REMOVAL OF THE STOMACH—SUCCESSFUL ŒSOPHAGO-ENTEROSTOMY—RECOVERY.

DR. EDMUND CHARLES WENDT, of New York, in an article recently published in The Medical Record, says: During my recent stay at Zurich, Switzerland, I was enabled, through the kindly courtesy of my friend, Dr. Carl Schlatter, personally to study the remarkable and unique case about to be described. At the date of the present writing, December 9, 1897, over three months since the operation of total ablation of the stomach, the woman is still under observation at the county hospital; but she is to all intents and purposes a well women, and does her full share of the daily work of the ward. On the date of my first visit I found her in a very cheerful frame of mind, and quite loquacious. She is already beginning to realize the interest and importance attaching to her case, as she has had medical visitors from many quarters of the globe. The lay press of all Europe has got wind of this extraordinary instance of a "live woman without a stomach." Garbled reports of her case have appeared in London, in Paris, in Berlin, in Vienna, and, perhaps, by this time, in New York.

It seems to me that the readers of The Record may well be congratulated upon receiving a detailed account of this case from the pen of the operating surgeon himself. It is only fair to mention, however, that, at the request of the editor of The Lancet, an abstract of this case has just been forwarded by Dr. Schlatter to London. I take this opportunity of expressing my sincere thanks to the young savant, who so cordially assisted me in my efforts to obtain for the American profession an authentic account of the case. On my several examinations of the patient I was particularly struck by her ruddy complexion, fair general appearance, clean, moist tongue, absence of all fœtor ex ore, moderately full and vigorous pulse, and general alacrity. She informed me that her appetite was good, but that she was never allowed to feel really hungry. She relished her meals, and her taste was unimpaired. Her bowels acted naturally once in twenty-four hours. The sleep was normal. She complained of no pain.

In a word, save for some degree of emaciation, a noticeably dry skin, and her abdominal cicatrix, the woman at present offers no apparent departure from ordinary average health. How long can she survive the non-existence of gastric digestion? Who can tell? Clinical observation sometimes rudely disturbs our most cherished school-taught physiological dogmas.

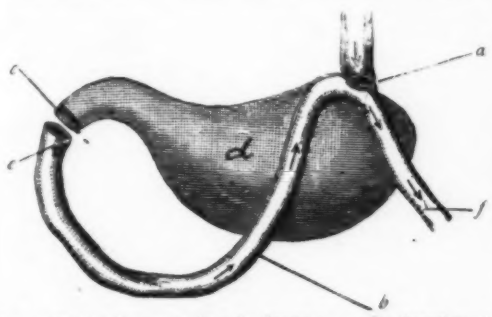


FIG. 1.—Showing Preparatory Steps for Operation. *a*, Œsophageal cut, *b* duodenum; *c*, duodenal slit; *d*, stomach; *e*, slit closed by suture; *f*, jejunum.

History of the Case by Carl Schlatter, M.D., the Operator.—The personal observation forming the subject of this paper relates to a woman fifty-six years old. In her case I completely excised the stomach, even beyond its cardiac extremity, and then restored the continuity of the alimentary canal by stitching a loop of small intestine into the lower end of the œsophagus, i. e., œsophago-enterostomy.

History of the Present Case.—Anna Landis, aged fifty-six years, silk weaver by occupation, claims that cancer is hereditary in her family. As a child she recalls having had frequent attacks of abdominal pain. According to her own notion, these attacks were due to the poor quality of the food at the orphan asylum where she was brought up. Later on she often complained of severe pains in the stomach, accompanied or followed by vomiting. She never saw bloody admixtures in the ejected matter, but large quantities of bile often came up. Medical treatment had never afforded her any relief. Ever since the spring of 1897 the attacks of vomiting were of daily occurrence. Progressive emaciation also ensued. Several weeks before her admission to the hospital a physician told her that she had a tumor of the stomach.

I first saw the patient at the surgical polyclinic on August 26, 1897. An inspection of the abdomen revealed a marked bulging between the left hypochondriac region and the umbilicus. The abdominal parietes were flabby, and palpation easily revealed an oval mass of hard consistency in the region of the stomach. The tumor was freely movable. Its size was about that of two fists. Very marked emaciation was found. The patient was unable to retain any kind of nourishment. She clamored for relief by surgical interference.

She was admitted to my wards for further careful observation. I did not feel confident that gastrectomy, or even gastro-enterostomy, could be successfully performed, on account of the large size of the tumor.

The patient continued to reject almost everything, including fluids. The iodide reaction of her saliva (after exhibition of iodide of potassium) required forty-seven minutes for its first appearance. The chemical examination of her gastric secretion showed no trace of free hydrochloric acid. An operation was, therefore, no longer delayed.

Description of the Operation.—On September 6, 1897, acting for Prof. Krönlein, I performed laparotomy under morphine-ether anæsthesia and with strict antisepsis—incision in the median line, extending from the ensiform process to the umbilicus. As I had anticipated, the entire stomach presented itself in the shape of a hard mass extending from the cardiac to the pyloric extremity. Strangely enough, the tumor was freely movable. It was readily lifted out of the peritoneal cavity. Three rather soft lymph nodes were found at the greater curvature near the pylorus. The stomach being diseased in toto, a gastro-enterostomy was impossible. I at once decided to attempt to excise the entire organ, or take recourse in a jejunostomy. I first freed the stomach from all its attachments at the greater and lesser curvature, having previously shut off the general cavity of the peritoneum by sterilized compresses. The omentum was incised between Péan's forceps. Silk sutures were used. The stomach was then forcibly dragged downward so as to enable me to reach the œsophagus. The left lobe of the liver had to be constantly held upward by an assistant, in order to permit me freely to manipulate within the field of operation. In this way I finally succeeded in securing the œsophagus rather high up, by means of a Wölfler clamp. A Stille forceps was next fastened closely to the cardiac end of the tumor. Then the stomach was severed directly beneath the œsophageal extremity. As the œsophageal incision appeared somewhat oblique, I proceeded to place a small occluding suture at the gastric wound. The same steps were now repeated at the pyloric end of the stomach.

I next mobilized the duodenum, as far as possible toward the head of the pancreas. Then, having applied a duodenal compressor, and likewise a tumor clamp, I removed the entire stomach, between the two points of compression. I also dissected out the lymphatic nodes above mentioned. The patent lumen of the duodenum was treated like the œsophageal opening with iodoform gauze. The broad bridge joining together different divisions of the alimentary canal had now been entirely removed.

I next tried to pull the duodenal opening upward toward the œsophageal cleft. It was only with considerable difficulty that the two could be made to touch. It was manifestly impossible to join them by direct suture. I, therefore, invaginated the duodenal rim, and closed the opening by a double suture. I then searched for a suitable coil of small intestine. Beginning at the duodenal-jejunal fold, I followed down the intestine for about fifteen inches. The presenting knuckle of intestine I grasped, and, pulling it over the transverse colon, I placed it against the œsophageal slit.

A piece of this intestine, about five inches in length, was secured between two Wölfler clamps. By means of sutures not going deeper than the serous coat, the intestine was then attached to the œsophageal stump. A longitudinal slit about one inch in length was then made into the bowel. Then the mucous membrane of the œsophageal end was firmly united with the intestinal mucous membrane, by a continuous circular suture. The material employed was silk. Above this, a second suture, extending through the muscular and serous coats, was introduced. A Lembert suture finally completed the stitching, which now seemed to hold.

The œsophageal and duodenal clamps were then removed, the former having remained in position for over two hours. On dropping back the organs into the abdominal cavity, the sutured portions showed marked retraction upward, toward the œsophageal part of the diaphragm. The abdominal wound was closed in the ordinary way by silk ligatures. Less than eight ounces of ether had been employed during the narcosis, which had fortunately been a very quiet one.

Pulse after the operation, 96 a minute, steady and of fair volume.

There had been only a very slight loss of blood during the course of the operation, which, however, had lasted nearly two hours and a half.

CLINICAL OBSERVATIONS FOLLOWING REMOVAL OF THE STOMACH.—Shortly after the operation the patient received an enema containing brandy and two eggs. Temperature in the evening, 36·4° C.

September 7.—Two nutrient enemas containing milk, eggs and brandy. Pulse rate has risen to 142, but in volume remains moderately good. Patient has taken per os, in the course of the afternoon, a small quantity of tea and milk, which is apparently well borne. No signs of peritonitis. Evening temperature, 37·3° C.

September 8.—Nutrient enemas no longer retained. Claret wine in teaspoonful doses given, until half a glass has been taken. Patient conplains of sudden abdominal pains, which, however, quickly subside. Evening temperature, 38·1° C.; pulse, 160, but of moderately good volume.

September 9.—Subjective symptoms considerably improved. At intervals of two hours, very small quantities of milk, eggs, bouillon and wine are given.

Small quantities of pepsin and muriatic acid have been tentatively added to the food. Pulse better, 146 per minute. Highest temperature 38·1° C.

September 13.—Dressing removed. The abdominal wound found united by primary intention without a trace of local reaction. Stitches removed. Patient allowed a little scraped meat for the first time. The first movement of the bowels since the operation took place September 10. Since then the patient has had from two to three fluid stools daily.

Occasionally there is some regurgitation of ingested milk, but actual vomiting has not occurred.

September 16.—Patient feeling remarkably well; temperature normal; pulse, 100; slight diarrhœa.

From now on the patient was able to take fairly large quantities of food. Mornings at 7, a cup of milk with one egg; 9:30, cup of milk with one egg. Dinner, very soft scraped meat, or a cup of thin gruel with an egg; 4 P. M., cup of milk with egg; 7:30 P. M., a cup of milk or gruel. In addition to these regular feedings, she also takes tea and Malaga wine, amounting in the course of the day to from five to seven ounces.

On September 16, for the first time since the operation, vomiting occurred. It was preceded by nausea, apparently superinduced by the patient having witnessed a change of dressing in a neighboring surgical case. There was a good deal of retching, and about seven ounces of bilious and slightly acrid fluid were ejected.

September 26.—Patient is allowed to have half a chicken, the last remnants of which she swallowed at 4:30. At 6:30, customary milk and egg. At 7:30, attack of vomiting with considerable retching and marked contractions of the abdominal muscles. The ejected matter amounted to about ten ounces, and consisted largely of milk and meat fibers. For some time before this attack patient had complained of a decidedly bitter taste in her mouth.

October 2.—Another attack of vomiting. The ejected fluid measured over six ounces. It was yellowish in color and not offensive. This attack came on one hour after eating. Examination showed that undigested egg and milk had been thrown up.

October 4.—An attack similar to the one just noted was observed.

October 8.—Another attack of vomiting. The slimy fluid was sent to the laboratory for chemical examination. The report received stated that the reaction of the fluid was distinctly acid. This was owing to the presence of lactic acid, as no free hydrochloric acid was found. Trypsin reaction was also discovered. Bile acids and bile pigment were likewise present in appreciable quantities. It should be mentioned, in this connection, that the patient was no longer taking pepsin and muriatic acid.

October 11.—Patient left her bed for the first time since the day of the operation, i. e., September 6.

November 25.—Patient feeling quite well and able to walk about comfortably.

There was a steadily progressive increase in the weight of the patient after removal of the cancerous stomach.

Practical Anatomical Observations.—I would like in the first place to say a few words in regard to the technique of the foregoing operation. Langenbuch,* in connection with his recorded gastrectomies, has published the following statements: "Of course my gastrectomies did not amount to total extirpation of the stomach. And, indeed, total ablation appears to be practically impossible toward the cardiac extremity of the stomach. For the cardiac portion has, like the head of the humerus, an anatomical as well as a surgical neck. Bearing in mind this anatomical peculiarity, it seems admissible to regard my operations as instances of total exsections of the stomach. For in both cases I removed as much of the organ as was technically possible."

Now the boundary line between the œsophagus and cardiac extremity of the stomach is clearly defined. The former is supplied with pavement epithelium: the latter shows the cylindrical variety. Personal observations and experiments on the cadaver fully confirmed this observation.

In the case of my patient it should also be borne in mind that as soon as the Wölfler clamp was removed, marked upward traction of the œsophageal stump was witnessed. Possibly the weight of the neoplasm had previously contributed its share toward dragging down the œsophagus. I cannot, therefore, accept the quoted statements of Langenbuch.

Physiological Observations.—It is well known that, considered merely as a food reservoir, the stomach exercises a highly beneficial influence over all ingesta. Food is retained for a shorter or longer period in the stomach, according to differences in its nature. To the bowel there is thus insured a measurable degree of safety from overloading. As a corrector of widely different degrees of temperature of various kinds of food, the stomach certainly fulfills an important office. The well known chemical and mechanical activities of the stomach, as also the disinfecting potency of its secretions, need not be specifically dwelt upon to establish the manifold importance of this organ. The bactericide action of gastric juice in cholera and other diseases need only be mentioned in passing. The capacity for absorbing certain liquids, while not so important as was formerly believed, should nevertheless also be borne in mind.†

Clinical Observations in Connection with the Obliteration of all Gastric Functions after the Operation.—There being no food receptacle after ablation of the stomach, it became obligatory to feed my patient at first with minute quantities of food, given at short intervals. The results of this method of procedure were in all respects happy ones. Quantities of food approaching ten ounces seemed to excite vomiting. So, too, cold fluids resulted in diarrhœal discharges, and may have been partly responsible for the rise in temperature, observed for some little time after the operation.

Keeping in mind the absence of mechanical function, the patient's dietary was at first a strictly fluid one. But as early as the second week after removal of the stomach, semi-solid and even solid food was allowed. It was retained and digested without discomfort. The patient having only a single tooth, mastication was of course quite imperfect, otherwise it seems to me possible that an ordinary mixed diet might have succeeded at a still earlier date.

Some weeks after the operation the patient's ordinary daily dietary was as follows: At regular intervals of from two to three hours she took milk, eggs, thin gruel or pap, tea, meat, rolls, butter and Malaga wine. The daily quantity amounted to one quart of milk, two eggs, two to three ounces of pap or gruel, seven ounces of meat, seven ounces of oatmeal or barley water (as thick almost as gruel), one cup of tea, two rolls and half an ounce of butter.

Personally I felt most concerned about the obliteration of all chemical activity on the part of the absent stomach. I soon perceived that adding pepsin and hydrochloric acid to the food was theoretically as inadmissible as it had been found practically valueless. The alkaline fluids of the intestine at once neutralized the acid, and rendered the pepsin inert.

Fortunately, it soon became apparent that despite the absence of acid pepsin, proteids were readily assimilated in the intestinal tract.

Does Removal of the Stomach Affect the Rapidity of Intestinal Propulsion?—Observations on this point are still being made, and at the present time I am unable to present any very definite conclusions. The patient objected to swallowing charcoal. Huckleberries were at three different times found in the passages, twenty-four hours after having been swallowed.

Conclusions by Dr. E. C. Wendt.—While it would be manifestly unfair to indulge in sweeping generalizations on the strength of this single case, so boldly rescued and ably described by Dr. Schlatter, it seems

* Deutsche medicinische Wochenschrift, p. 969, 1894.

† Note by the commentator: I have thought it advisable, in order to curtail the length of this communication, considerably to abbreviate this portion of Dr. Schlatter's interesting remarks.—E. C. W.

at least justifiable to formulate the following conclusions:

1. The human stomach is not a vital organ.
2. The digestive capacity of the human stomach has been considerably overrated.
3. The fluids and solids constituting an ordinary mixed diet are capable of complete digestion and assimilation without the aid of the human stomach.
4. A gain in the weight of the body may take place in spite of the total absence of gastric activity.
5. Typical vomiting may occur without a stomach.
6. The general health of a person need not immediately deteriorate on account of removal of the stomach.
7. The most important office of the human stomach is to act as a reservoir for the reception, preliminary preparation and propulsion of food and fluids. It also fulfills a useful purpose in regulating the temperature of swallowed solids and liquids.
8. The chemical functions of the human stomach may be completely and satisfactorily performed by the other divisions of the alimentary canal.
9. Gastric juice is hostile to the development of many micro-organisms.
10. The free acid of normal gastric secretions has no power to arrest putrefactive changes in the intestinal tract. Its antiseptic and bactericide potency has been overestimated.

ITALIANS IN AMERICA.

THE November Bulletin of the United States Department of Labor contains, as usual, a remarkable amount of interesting and valuable matter. The first article treats of the Italians in Chicago, and contains some curious statistics. There are probably ten thousand Italians in Chicago, and the agent of the commission visited more than thirteen hundred families, containing nearly seven thousand persons; so that his information is probably correct, in the main, for the Italians in the country at large. It seems that the immigration to America is mainly from Southern Italy, about one-half coming from Campania and the Basilicate, while Sicily, Calabria and the Abruzzi furnish nearly all the rest. It is not surprising that provinces which have been renowned for two thousand years for the half savage character of their inhabitants do not furnish an extremely polished or intelligent class of citizens to Chicago and Boston; and the solicitude of the commission's agent, who seems to know by experience the pains of dyspepsia, over the lack of hygienic knowledge among people whose fathers and grandfathers were little removed from brigands is rather amusing.

Although the Italian immigrants are ignorant and undeveloped, they show, according to the statistics, a surprising capacity for improvement, and a generation or two hence it is probable that they will form an influential part of the composite race which is rapidly displacing the Anglo-Saxons in America. The life of new settlers in a strange land gives probably some notion of the ideal of existence which prevails among them, but which they could not realize at home; and it is curious to find that the women, who, in Italy, earn a large part of the subsistence of the family, are, in America, to a great extent released from the hard necessity of working among strangers for bread; so that, among the Italians in this country, a remarkably small proportion of the women are engaged in what the statisticians call "gainful occupations," as contrasted with the less gainful, but more congenial, feminine employments of keeping house in their little tenements and looking after the children.

Another noticeable characteristic of the American Italians, particularly of the men, is their fondness for good living, of which, considering that their wages are only those of the lowest and most ignorant laborers, of inferior bodily as well as mental development, they manage to secure a surprising amount. A list is given of typical bills of fare for sewer diggers and day laborers, both married and single. Sewer digger number one, married, reports that he has beefsteak for breakfast three times a week, and again for lunch on the same days, eating half a pound for his breakfast, and another half pound for lunch. The other three working days he has red peppers, fried, in place of beefsteak, at these meals. For supper he has macaroni and beans, or beefsteak and fried potatoes. With each meal he has bread, and he washes down his breakfast and supper with beer, to the value of five cents on each occasion. What his carte for Sunday is does not appear, as the statistician made no inquiries in regard to this day in any case.

In nearly every case, the sewer diggers and laborers had beef or pork chops and beer at least once a day, and often twice, or even three times, the only exception noted being in the case of a young man of twenty-three, who drank no beer, and ate meat regularly once a day, choosing ham or sausage for his lunch, and indulging in beefsteak occasionally for supper. Although nearly all the food is fried in lard, and is thus much less commendable than the "oatmeal and other prepared cereals" which the statistician regrets to find that the Italians have no taste for, it is likely to do something toward the physical development of a race which has starved for generations at home on macaroni and "polenta," and dietetic wisdom may come with the habit of well filled stomachs.—American Architect.

The census of the German empire, ordered taken last summer by the imperial minister of the interior, has just been announced. One city goes beyond the million mark—Berlin, with 1,677,135 inhabitants. Hamburg has a population of 625,000; Munich, 407,000. Four cities have over 300,000: Leipsic, 399,969; Breslau, 373,000; Dresden, 336,000; and Cologne, 321,000. Three cities have over 200,000 inhabitants: Frankfort-on-the-Main, Magdeburg, and Hanover. The five cities having 150,000 to 200,000 inhabitants are Düsseldorf, Königsberg, Nuremberg, Schemnitz and Stuttgart. Thirteen cities have from 100,000 to 150,000—Altona, Bremen, Stettin, Elberfeld Strasburg (135,000), Charlottenburg, Barmen, Dantzic, Halle, Brunswick, Dortmund, Aix-la-Chapelle and Crefeld. Twenty-seven towns have from 50,000 to 100,000: and forty-seven have from 30,000 to 50,000. This makes a total of 102 cities having populations over 30,000. The entire population of the empire is 52,250,894, showing very little difference from the census of December 2, 1895, whose total was 52,279,901.

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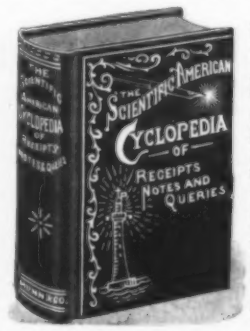

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